

The Milbank Memorial Fund
QUARTERLY

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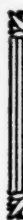
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IN THIS ISSUE

QUANTITATIVE information on the vitamin content of foods is an essential for planning diets and, therefore, convenient, up-to-date tables of the vitamin values of common foods are always in demand. The discovery of new vitamins and new information on the chemical identity of vitamins, which leads to refinements in the technique of evaluating foods, are requiring constant changes in tables of vitamin values. To assemble the data which come from many laboratories is a large task. In "Vitamins and Their Occurrence in Foods," Dr. Hazel Munsell not only presents a table giving carefully selected average values for many foods but also reviews the newer knowledge relating to factors which produce variability in the content of a specific food. Methods of cooking have a marked effect on vitamin content of foods at the time they are eaten, but soil, methods of producing, season, storage, and other factors also may be important.

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In the last issue of the *Quarterly* there appeared three of the six papers presented at the Round Table on Population Problems, held as part of the Fund's Eighteenth Annual Conference. The concluding three are presented in this issue and bound reprints of the complete symposium will soon be available under the general title, "Population Trends and Programs of Social Welfare." The initial paper in the present group was prepared by Dr. Ewan Clague and entitled "The Aging Population and Programs of Security." The steady rise in the number and proportion of the aged in our population not only increases the gross burden of old-age dependency accruing from present provisions, but also increases the articulate demands and the voting strength of persons past middle age. Dr. Clague appraises several possible methods of handling the problems of dependency of the old and of unemployment among the nearly-old.

In the next paper, "Population Trends and Problems of Public Health," Mr. G. St.J. Perrott and Dr. Dorothy F. Holland discuss the bearing of changing age composition on the future course of public health activities. For suggestive indications of the future volume of illnesses and deaths from chronic conditions and other causes, the authors present figures based upon application of age-specific morbidity and mortality rates to the estimated population, by age, in the decades to come. Similarly, rough estimates are presented concerning trends in the possible needs for various types of medical services in the future.

The concluding paper in this series was written by Dr. Philip Klein under the title, "Adapting Programs of Social Welfare to a Changing Population." Dr. Klein presents his views on the broad economic bases of social problems and stresses the bearing of population changes on the conditions of our economy. He devotes particular attention to current complaints concerning unemployment, restriction of investment opportunities, and expensiveness of public welfare programs. He gives his conception of the type of long-time program that is indicated by current trends in population and by present economic maladjustments.

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Among the newer diagnostic tests developed for detecting nutritional deficiencies, instruments for measuring visual dark adaptation have received widespread attention as a method for detecting avitaminosis A. In the second paper from a survey being conducted in New York City, "Medical Evaluation of Nutritional Status," Dr. Eleanor P. Hunt and Dr. Carroll E. Palmer discuss various technical problems involved in the use of the adaptometer developed by Hecht and Shlaer. This report evaluates the accuracy of the instrument and gives the basis for standardizing the results of tests from all similar instruments. Such standardization is extremely important in order that results obtained for different population groups and by different workers in this field may be compared.

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VITAMINS AND THEIR OCCURRENCE IN FOODS

HAZEL E. MUNSELL¹

INTRODUCTION

THE first vitamins were discovered less than three decades ago but since then an almost phenomenal number of substances has been classified in this nutritionally important group. A complete listing at the present time would include as many as forty or more and there are indications of the existence of still others.

The presence of vitamins in foods was recognized from observations of the almost spectacular effect certain foods have on growth, function, and general well-being of the body. For centuries it had been known that the juice of limes or lemons would prevent or cure scurvy, but there had never been an adequate explanation of this relation. When it was demonstrated that a substance in the outer coating of the whole rice grain would cure or prevent the disease known as beriberi, and that butter and egg yolk contained a substance required for growth and for the prevention of a peculiar type of inflammation of the eye, it became apparent that foods contain certain substances other than protein, carbohydrate, fats, and minerals which are likewise essential for normal nutrition.

The substances in foods credited with these properties were distinguished by descriptive terms as the antiscorbutic, antiberiberi, and antiophthalmic factors, respectively, or on the basis of their solubility, as water-soluble C, water-soluble B, and fat-soluble A. When the name vitamin, from the term "vitamine" originally used for the antiberiberi substance, was suggested for them as a group they were designated vitamin C, vitamin B, and vitamin A. Since the chemical composition of the vitamins became known several of

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them have received names related to their chemical structure. Thus, vitamin C is now known as ascorbic acid, vitamin B₁ as thiamin, vitamin G or B₂ as riboflavin, and vitamin B₆ as pyridoxine.

For various reasons a number of the water-soluble vitamins have been grouped together as the vitamin-B-complex. Vitamin B₁ and vitamin G were the original members of this group which now includes nicotinic acid and vitamin B₆ as well as five or six other factors not mentioned in this discussion.

The number of vitamins actually known to be essential in human nutrition is relatively small. The importance of vitamins A, B₁, and C in the diet is now well known. It is certain that vitamin D is a requirement of children, and while it may be needed by adults as well, perhaps in lesser amounts, this is yet to be demonstrated. Evidence of the significance of riboflavin (vitamin G) in the diet of man has been obtained within the last two years, and we now have a clear picture of the external symptoms that follow the use of a diet deficient in this factor. Since the announcement in 1937 of the value of nicotinic acid in the cure of the disease in animals which is comparable to pellagra in man, considerable information has accumulated to establish the value of this substance as a pellagra-preventive. There is still some question as to whether nicotinic acid and/or nicotinamide can unreservedly be designated the pellagra-preventing or P-P factor or factors, but there can be no doubt that they are specific in their effect on certain symptoms of pellagra. The substance in foods which is referred to as vitamin K helps promote the clotting of blood, and the supposition now is that it functions in man, as well as in animals in maintaining a normal level of prothrombin in the blood. An anemia which occurs in chicks given a diet deficient in vitamin K responds to treatment with extracts containing this vitamin.

These are the vitamins definitely known to be required by man. There is also considerable evidence in favor of two others, vitamin E and vitamin B₆. Vitamin E (alpha-tocopherol) has been shown to

be important for normal reproduction in several species of animals and it may be required for successful reproduction in the human species as well. Both vitamin E and vitamin B₆ are being actively investigated at the present time.

The importance of the vitamins to normal nutrition is now fully recognized although there is still a great deal to learn about these substances. In planning foods for the day it is essential to know how to select them for vitamin values as well as for their content of protein, carbohydrate, fat, and minerals. The purpose of this article is to give a brief and not too technical presentation of our knowledge of the properties and food sources of these vitamins. A brief description of the method of quantitative expression used for them and a table of values for vitamin A, vitamin B₁, vitamin C, and riboflavin content of common foods is also included.

PROPERTIES AND FOOD SOURCES

GENERAL CONSIDERATIONS

The most distinctive common characteristic of the vitamins is the fact that they occur in foods in almost infinitesimal quantities and are effective in the body in similarly small amounts. Beyond this they have little in common since they differ markedly both in their physical and chemical properties. Some are soluble in water while others dissolve only in fats and fat-solvents. Some are easily destroyed, especially at high temperatures and when oxygen is present, as when foods are heated in air. Others are fairly resistant to destruction by heat even when heated for several hours at temperatures well above the boiling point of water. In the case of nearly all of them, however, destruction takes place more rapidly in alkaline than in acid solution.

In estimating the vitamin value of foods in the diet it is essential to know and keep in mind the properties of the various vitamins in order to be able to take account of possible losses. Consideration of changes that occur in the vitamin content of foods during processes

connected with preservation and preparation, such as storage, freezing, cooking and canning, and drying, is of as much importance as consideration of the vitamin content of the fresh or untreated food. A food which, in its original state, is a perfectly good source of one or more of the vitamins may have its content of one or all of these factors reduced to insignificance as a result of the treatments it undergoes during preparation for consumption. Loss of vitamin value may be brought about not only as a result of inactivation or destruction of the vitamins but also through their mechanical removal by solution, the vitamin passing out of the food material into the surrounding liquid.

While vitamins are found in foods of both plant and animal origin, plants—generally speaking—should be considered the primary sources since animals depend upon plants for their supply of most of the vitamins. This does not mean that the substance responsible for vitamin value in plant tissue is always the same as that having a similar function in animal tissue. Vitamin A, for instance, does not occur in plants, the vitamin-A value of plants being due to certain orange-yellow substances called carotenoids. These are broken down in the liver of the animal so that vitamin A is derived from them, and for this reason the carotenoids are sometimes called the "precursors" of vitamin A.

It is now well known that foods show marked differences both in the kinds and amounts of vitamins they supply. Differences in the vitamin values of different foods do not constitute the only problem of variation that must be considered, however. There is the equally important matter of variation from sample to sample of a single food item. While it may generally be taken for granted that samples of a given food, selected at different times, will contain the same kind or kinds of vitamins, it does not necessarily follow that they will contain equal quantities of any kind. The idea must not be held with respect to any natural food, that it has a definite and fixed content of any vitamin—unless, perchance, it is zero.

The problem of sample variation in vitamin content of foods is responsible for some of the newer phases of vitamin research, especially in connection with studies related to food production. Some of the factors associated with this variation have been identified but there is still much to be learned. In foods of plant origin, variety in a given kind is very often an important factor in relation to vitamin content. Age and maturity of the product, its size, the amount and kind of fertilizer used in cultivation, the amount of moisture present in the soil, and the degree of exposure to sunlight may also have considerable influence. In foods of animal origin the breed of the animal from which the food comes, as well as its age and physical condition, is sometimes of significance, but the most important factors are the vitamin content of the animal's food and, in the case of vitamin-D value, the length of time the animal was exposed to sunshine. This sums up to the conclusion that values for vitamin content can in no sense be considered exact unless correlated with an adequate knowledge of the conditions that might have had an influence on them.

A point of considerable practical importance in dealing with vitamin values for foods is the fact that relative vitamin potency may easily be discussed by reference to food groups or food types. A diet can be planned on the basis of food groups rather than individual foods, thus lessening the tendency to place undue emphasis on one food that may have been shown to be very rich in a particular vitamin.

VITAMIN A

Properties. Vitamin A belongs to the group of fat-soluble vitamins and is practically insoluble in water. The pure vitamin, prepared by freezing it out of solution, is a pale yellow, viscous, oily substance. It is not readily broken down by heat but is inactivated by oxidation, especially when heated in a medium where there is free access of oxygen.

As already explained, the vitamin-A value of foods of plant origin

is due not to vitamin A, since this substance does not occur in plants, but to the presence of orange-yellow pigments called carotenoids—"precursors" of vitamin A. There are four of these substances: alpha, beta, and gamma-carotene, and cryptoxanthin. Beta-carotene is by far the most important and most widely distributed in natural food products. Cryptoxanthin occurs in only a few foods.

The carotenoids, like vitamin A, are soluble in fats and fat-solvents and are not readily inactivated by heat except as oxygen is present.

Food Sources. The vitamin-A precursors may occur in any part of a plant—root, stem, leaf, flower, fruit, and seed. There is considerable variation, however, in the amounts present in foods of plant origin. Many contain them in abundance, and some carry only small amounts or none at all.

An orange-yellow color in foods of plant origin indicates the presence of one or all of the plant carotenoids from which vitamin A may be derived and furnishes a rough index of vitamin-A potency in many vegetables as well as in fruits. Carrots and sweet potatoes are outstanding examples of this relationship. This index holds good where there are yellow and white varieties of a given product. Yellow turnips, yellow peaches, yellow corn, and yellow tomatoes are sources of vitamin A whereas the corresponding white varieties are not. To avoid confusion as to the application of these findings a word of caution seems advisable here. The fact of the presence of vitamin A in yellow varieties of foods is no reason for ignoring the white varieties. They may have values the yellow ones do not have. There is a place in the diet for all types of foods and there is little or no reason for consistently using certain ones and excluding others. Care should be taken to avoid applying factual information on food values in a fanatical way.

A yellow color is not invariably associated with vitamin-A potency, for there are yellow plant-pigments that do not yield vitamin A. A red color has no relation to vitamin-A value and is not indica-

tive of it except that in some foods a red color may mask the orange-yellow of carotene. An example is the red-fleshed tomato containing carotene either in the flesh or the skin.

Experience has led to the recognition that a green color^a in plants indicates vitamin-A value. Green leaves, and more especially thin green leaves like those of spinach, kale, dandelion, and leaf lettuce, are among the richest sources of vitamin A. Other green foods that are notable in this respect are green string beans and green peppers. The stems of asparagus, celery, and broccoli, and many other plants, may be appraised for vitamin-A value on the basis of greenness. Bleached parts of plants that would normally be green but do not have the green color, either because the chlorophyll never developed or because it was destroyed as in the case of winter cabbage, the inner leaves of lettuce, and the bleached stems of asparagus and celery have practically no vitamin-A value.

In general, roots and tubers may be accepted as low in vitamin-A value with the exception of carrots and sweet potatoes, as noted above. Seeds, including nuts, cereal grains, and legumes (peas and beans), are on the whole low in, or totally devoid of, vitamin-A value unless they have some green or yellow color as peas and yellow corn.

Vegetable oils contain little or no vitamin A.

Among the foods of animal origin, eggs and milk are important sources. The hen and the cow do not convert all of the carotene obtained from their feed into vitamin A and eggs and milk contain both vitamin A and carotene. In both cases the proportion of vitamin A is much higher than that of carotene. The ratio between the quantities of these two substances in milk from different breeds of cows may be significantly different; some breeds, for instance, consistently giving milk which contains a higher proportion of caro-

^aChlorophyll, the green coloring matter of plants, does not itself form any part of vitamin A, but the high concentration of this vitamin in parts of the plant where chlorophyll functions has led to the suggestion that it may play a rôle in the formation of the vitamin. Vitamin-A potency in other parts of the plant would in that case be due to substances transported to them for storage.

tene than others. Since vitamin A is soluble in fat and only slightly, if at all, soluble in water, the vitamin-A value of the egg is in the yolk and that of milk is in the cream. Butter is an important source of vitamin A, and other milk products, such as cheese, contain it in proportion to the quantity of milk-fat present.

Eggs and milk show wide variations in vitamin-A values. The total quantities of both vitamin A and carotene in eggs and milk are influenced by the quantities present in the feed of the respective animals producing these foods. During the summer months, when green feed is available, milk and eggs may show radically higher values than during other months of the year, although present-day feeding practices, by the use of feeds of high vitamin-A value throughout the year, tend to eliminate seasonal variation.

In contrast to its precursors, the carotenoids, vitamin A has very little color. Inasmuch as milk and eggs contain both carotene and vitamin A, color is of little value in judging their vitamin-A potency. This is especially true of eggs. If the hen derived vitamin-A value from green feed or products rich in carotene, the yolk of the eggs will be deep yellow in color and will have a high vitamin-A value. If the hen did not have access to green feed or other highly colored food, but was given feed containing cod-liver oil, which contains vitamin A but not carotene, then the yolk of the eggs will be very light in color and still will be rich in vitamin A.

Meats vary considerably in their vitamin-A value since much more of this factor is stored by some tissues than by others. Liver, especially, retains large amounts of it when there is an abundance of the vitamin in the diet, which makes it a rich food-source but from the standpoint of cost it can hardly be considered an important one. Glandular organs, other than liver, contain fairly large amounts of the vitamin but, like liver, they are available in limited quantities. Lean muscle meats contain only small quantities of vitamin A.

Losses of Vitamin-A Value. Vitamin A and its precursors are not greatly affected by any of the processes connected with food preser-

vation and preparation unless there is considerable chance for oxidation. Foods that are stored show a loss only after prolonged storage. This is greatest in foods that have been dried preparatory to storing, such as dried grasses and dried fruits. Even though such foods were good sources to begin with, they may lose as much as 50 per cent of their vitamin-A value in a few months' time. Boiling and steaming cause practically no diminution in vitamin-A content. Losses have been noted as a result of baking but they are not serious; in roasting, destruction of vitamin A is appreciable.

As would be expected there is little or no loss of vitamin A when foods are canned. During storage the vitamin-A content of canned foods may decrease but this change takes place gradually and usually is not appreciable up to nine months.

VITAMIN B₁ (THIAMIN)

Properties. Vitamin B₁ is a white crystalline material that is soluble in water. In plants it seems to exist in relatively simple combination and may be removed fairly easily by extraction with water. In animal tissue it is present in more complex form combined with phosphate.

Vitamin B₁ is described as heat labile—that is, unstable when heated. Inactivation depends entirely, however, upon conditions under which it is treated. In acid solution it is relatively stable but in neutral or alkaline solution it is readily broken down, the rate of destruction being higher with increase in alkalinity, temperature, and time of heating. The rate of destruction of the vitamin is also higher when it is heated in solution or in mixtures that are moist than when heated in dry mixtures.

Food Sources. Vitamin B₁ occurs in practically all foods derived from plants with the exception of fats and oils, but there are very few concentrated sources. Vitamin-B₁ values of foods seem to be less subject to the influence of conditions of production and are therefore somewhat more constant than other vitamin values.

The relatively low concentration of vitamin B₁ in foods and the lack of sensitivity of the methods for measuring it have not made it possible to determine its distribution in the different parts of plants as closely as in the case of some other vitamins. Seeds, including grains, nuts, and legumes, are known to be among the richest sources. In grains, the vitamin is concentrated in the embryo and outer covering. In the process of refining, these parts are largely removed, hence the importance in the diet of whole grain breads and cereals from the standpoint of vitamin B₁.

All fruits and vegetables contain some vitamin B₁. Although none of them is a rich source, they should be considered important sources since they comprise a part of all diets and are usually eaten in relatively large amounts. Potatoes should be considered especially in this respect.

Milk is a good source of vitamin B₁ in that it is generally consumed without having been subjected to treatment other than pasteurization which entails little loss of the vitamin. Eggs are also a good source, the vitamin being in the yolk.

Meats should probably be rated as good sources of vitamin B₁, although information concerning this is not very complete. For reasons not yet determined pork has a vitamin-B₁ content two or three times greater than other meats, and the dark meat of chicken may be richer than the light meat. Glandular organs, liver and kidney for example, are somewhat richer than muscle meats.

Fats and oils do not contain vitamin B₁.

Losses of Vitamin B₁. In considering loss of vitamin B₁ in foods it is essential to keep certain facts clearly in mind: (1) the vitamin is soluble in water; (2) it exists in foods in different combinations which may have a bearing on the ease of removal and also on its destruction; and (3) inactivation of the vitamin depends upon conditions,* and the quantity destroyed cannot very well be ex-

* Acid solutions containing vitamin B₁ have been heated as long as one hour at 120°C. without appreciable deterioration of the vitamin. In slightly alkaline solutions losses ap-

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pressed by a definite percentage but is more a matter of rate of destruction.

When foods are cooked by boiling, the proportion of vitamin B₁ destroyed is relatively small up to cooking periods as long as one hour, and generally does not exceed 10 to 15 per cent unless the food is distinctly alkaline or has been made so by the addition of soda. The loss by solution, on the other hand, may be considerable, depending, in addition to other factors noted, upon the proportion of water used. Larger amounts of water remove more of the vitamin. The proportion of vitamin B₁ found in water in which food has been cooked has been reported as high as 50 per cent of that originally present in the food. If this water is used there will be little loss of the vitamin.

Baking causes only slight, if any, destruction of vitamin B₁ but the higher temperature and longer time required for roasting results in appreciable destruction.

In canning there is apparently no loss of vitamin B₁ from processing, the greatest loss taking place during blanching or other procedures where there is a chance for solution. There are very few data to support a statement concerning the effect of storage on vitamin B₁ in canned foods. Losses noted were determined after about six months' storage and ranged around 40 per cent.

Practical information on the inactivation of vitamin B₁ in foods during drying is almost entirely lacking. The vitamin seems to be retained fairly well by foods dried at a temperature of 60°C. but at higher temperatures destruction is probably considerable.

VITAMIN C (ASCORBIC ACID)

Properties. Vitamin C in its pure form is a white crystalline material with an acid taste and is readily soluble in water. It is inactivated by oxidation and the rate of destruction increases rapidly with in-

proximated 30 per cent during one hour of heating at the boiling point of water. Dry mixtures containing vitamin B₁ have been heated at 100°C. for as long as forty-eight hours and have shown no detectable change in their vitamin-B₁ content.

crease in temperature. The degree of acidity of the mixture also has a marked influence on the stability of vitamin C. In an acid mixture like tomato juice it is destroyed only slowly, but in less acid solution the rate of destruction is much more rapid.

Inactivation of vitamin C by oxidation proceeds in two steps. By mild oxidative processes a substance called dehydro-ascorbic acid is formed. This substance, which functions in the animal body as vitamin C but does not respond to the usual chemical test, may be reduced to ascorbic acid. Under more drastic conditions of oxidation the vitamin is completely inactivated and its activity may not be restored.

Food Sources. Vitamin C may well be called the vitamin of fresh foods. This does not mean fresh from the market, but fresh from the plant or animal that produced the food. One authority has said, "with the exception of ripe seeds, practically all fresh foods of either plant or animal origin contain generous amounts of vitamin C."

Fruits and vegetables are, on the whole, the richest sources of vitamin C. There is a tendency, however, to limit the emphasis to fruits and vegetables that can be eaten raw, and more especially to the citrus fruits and tomatoes. Since these specific products are not only outstandingly rich sources of the vitamin but also retain their potency remarkably well during the various treatments to which they may be subjected, they have come to be considered almost essential in the diet. This tendency should probably not be encouraged to the extent of diverting attention from other fruits and vegetables that are equally important for vitamin C. In some localities and at certain times of the year other fruits and vegetables, if handled so as to conserve their vitamin-C value, might be more economical than citrus fruits or tomatoes.

Other fruits that may be considered important from the standpoint of vitamin-C content are strawberries, blueberries, and cranberries. Among the vegetables, peppers are outstanding in the quantity of vitamin C they contain. Cabbage and other members of the

cabbage family, cauliflower and Brussels sprouts, and turnips and rutabagas also contain large amounts. Vitamin C occurs in fairly high concentration in all leaves such as spinach, collards, turnip greens, and watercress.

Variation in vitamin content according to variety has been studied more extensively with respect to vitamin C than for any of the other vitamins. Rather wide varietal differences have been shown for apples, tomatoes, oranges, and cabbage. In the case of oranges several other factors are known to influence vitamin-C content, making varietal differences as studied of lesser importance. Fully ripe fruit contains more of the vitamin than partially ripe fruit, and that exposed to sunlight is richer than that from the shaded side of the tree. The vitamin-C content of a given variety of orange decreases progressively as the season advances although this change is less pronounced for some varieties than others. Conditions of cultivation also have an influence, but these are not as well defined as other factors. The extent of differences that exist in the vitamin-C content of oranges may be illustrated by values obtained in the Bureau of Home Economics on a dozen oranges examined individually. These oranges were of uniform size and appearance and were purchased at one time and came from a single bin in a store in Washington, D.C. The vitamin-C content ranged from 24 to 60 milligrams of ascorbic acid per 100 milliliters of juice.

Factors other than variety that may influence vitamin-C content have also been studied with apples and tomatoes. With apples, size is significant. In this fruit the vitamin is concentrated in the skin and in the flesh just under the skin. Since the proportion of skin to flesh is greater in small than in large apples, a small apple contains more vitamin C in proportion to its weight than a large one. In tomatoes there is a gradual increase in vitamin-C content as the fruit matures while during the actual process of ripening there may be a decrease.

Milk and meats should not be considered significant sources of

vitamin C. Milk as it comes from the cow contains an appreciable amount, but this is inactivated rapidly as the milk stands. Meats are not important sources because whatever vitamin C they contain is destroyed during cooking. Eggs do not contain vitamin C.

Vitamin C is not present in fats and oils since it is soluble in water and not in fats.

Losses of Vitamin C. Loss of vitamin-C value from foods may occur as a result of inactivation by oxidation or removal of the vitamin by solution.

Consideration of losses from oxidation require mention, at least, of factors pertaining especially to this vitamin. Some fruits and vegetables contain substances called oxidases that accelerate the rate of inactivation of vitamin C by oxidation. These substances in turn are inactivated by heat and are destroyed in a short time when kept at the boiling point of water. Small amounts of copper coming from utensils and containers also catalyze, or hasten the oxidation of vitamin C. Some foods also contain within their tissues an amount of oxygen sufficient to be a factor in the oxidation process.

Deterioration of vitamin C begins in all foods as soon as they are removed from the environment in which they were produced. This is the reason for indicating carefully what is meant by "fresh foods" from the standpoint of vitamin-C content. The rate of inactivation of vitamin C in fruits and vegetables that are allowed to stand seems to depend upon their physical characteristics. Thin leaves like spinach lose vitamin C rapidly and may retain no more than 50 per cent after standing two or three days. Peppers having a smooth compact outer covering, show little loss. In apples the loss is gradual and ripe tomatoes may be stored as long as ten days without detectable change in vitamin-C content. Rate of inactivation in all such products increases with increase in temperature so that loss is less when they are kept under refrigeration.

In plant products inactivation is more rapid when the plant cells have been opened up so that the vitamin is exposed to oxygen. De-

crease in vitamin-C content takes place in vegetables that are prepared for cooking or canning and then allowed to stand. Foods that are chopped or crushed lose vitamin C rapidly and may contain appreciably less of the vitamin after standing only a few hours. The rate of destruction of the vitamin is less, however, at low temperatures in such cases. Expressed juices like orange juice and tomato juice may be stored in covered containers at household refrigerator temperatures for as long as twenty-four hours with no detectable change in vitamin-C content. Rate of destruction after that time depends upon whether the oxidases have been previously destroyed by heating. Canned tomato juice, after the can is opened, shows little change in vitamin-C content after several days' storage in a refrigerator.

Heat markedly accelerates the rate of destruction of vitamin C and cooked foods are not dependable sources of this vitamin. Tomatoes are a notable exception since they are rich sources to begin with and due to their high acidity they show loss of the vitamin only after prolonged heating. In foods that contain oxidases destruction of vitamin C during cooking is very rapid at first or until the temperature is reached at which the oxidase is destroyed when it proceeds at a much slower rate. To preserve vitamin-C content during cooking, foods should be cooked quickly. They should also be served immediately since cooked foods lose vitamin C more rapidly when allowed to stand than do raw ones.

When foods are boiled some of the vitamin C they contain may dissolve in the cooking water. This dissolved vitamin may be conserved, obviously, by using the water. The proportion of vitamin C destroyed in foods that are boiled averages 20 to 25 per cent while 30 to 40 per cent may be present in the cooking water depending upon the amount used.

Foods that must be cooked at temperatures higher than that of boiling water do not retain enough vitamin C to require consideration.

Reduction in vitamin-C content from canning is less than in foods cooked by other methods since air is largely excluded during processing. Decrease in vitamin-C content is greater in foods that are preheated in an open kettle before they are put into the can than in those canned by the cold pack method. Blanching may cause some loss of vitamin C through solution, but this procedure at the same time effects inactivation of any ascorbic acid oxidase present.

Canned foods may be stored several months without showing serious decrease in vitamin-C content, but when deterioration once begins it proceeds rapidly. Inactivation of vitamin C in canned goods is directly and specifically related to the size of the head space, hence, this should be kept as small as possible. Conditions of storage do not seem to be closely related to rate of loss of vitamin C in canned foods. The question as to whether loss is greater in foods canned in tin or in glass is still in the controversial stage.

In considering canned foods as sources of vitamin C, one important point must be kept in mind. Such foods have been cooked at a fairly high temperature and the cellular structure is largely broken down. If they are allowed to stand after removal from the can or are heated and then allowed to stand they will not have very much vitamin C. Tomatoes are an exception since they retain vitamin C well under most conditions because of their high acidity.

Drying of foods is very destructive of vitamin C. Some dried products—fruits—have been reported as containing small quantities, and sulphured foods are supposed to contain more than others; but the amounts left even in foods that have just been dried are so small that it seems safer on the whole to disregard dried foods as probable sources of this vitamin.

VITAMIN D

Properties. At least ten different substances are known to have vitamin D activity but only two of these are of practical importance. They are vitamin D₂ or activated ergosterol, known also as calci-

ferol, and vitamin D₃ or activated 7-dehydro-cholesterol. Ergosterol which is found only in plant tissue, and 7-dehydro-cholesterol, which is associated with cholesterol, the sterol in animal fats, are often called provitamins. Under the influence of ultraviolet light (irradiation) they are changed into active forms of vitamin D. The commercial preparation known as Viosterol, is a solution of activated ergosterol in oil.

The relative activity of these two forms of vitamin D is different for different species of animals. A preparation of vitamin D₂ or calciferol, judged by tests with rats to have the same activity as a given preparation of vitamin D₃, will be judged to be considerably less potent when examined by tests with chicks. Thus, while, for a given effect, chicks may require the same amount of vitamin D₃, they will require more vitamin D₂.

Vitamin D (D₂ and D₃) is soluble in fats and is not affected by heat or oxidation.

Food Sources. Vitamin D does not occur to any extent, if at all, in foods of plant origin, but plants do contain the provitamin, ergosterol. Dried plant tissue containing ergosterol acquires properties of vitamin D on exposure to ultraviolet light. Yeast contains large amounts of ergosterol and irradiated dried yeast is an important source of vitamin D.

The only significant natural sources of vitamin D are among the foods of animal origin. These include milk, eggs, liver, and fish that are rich in oil, like salmon and herring. The value of these foods as sources of vitamin D may well be questioned, however. The quantities of the vitamin that they contain are so small compared to the quantities needed by children for protection against rickets as to be of little practical value in this respect, and if adults require vitamin D it is difficult to believe that the quantity is as small as that ordinarily supplied by the use of these foods. This statement does not apply to fish-liver oil, which is the richest natural source of vitamin D. Since foods of animal origin are the only ones that contain vita-

min D naturally, and they contain only vitamin D₃ this form of the vitamin is sometimes referred to as natural vitamin D.

The vitamin-D content of milk and eggs may be increased by feeding the animals producing these foods some rich source of the vitamin. Cows may be given irradiated yeast. "Metabolized" vitamin-D milk is produced in this way. The greater proportion of the vitamin D in such milk will be vitamin D₂ with the small quantity of natural vitamin D normally present. Eggs of high vitamin-D activity are obtained by including cod-liver oil in the hen's feed so that eggs generally contain only natural vitamin D.

Milk may also be enriched in vitamin D by irradiating the cow, by irradiating the milk, or by adding concentrates of the vitamin directly to the milk. Only the last two methods have been used to any extent commercially.

RIBOFLAVIN (VITAMIN G)

Properties. Pure riboflavin is a yellow crystalline material readily soluble in water, giving a yellow-green fluorescent solution. Riboflavin is not readily destroyed by heating but is less stable in alkaline than in acid solution.

As it occurs in nature, riboflavin forms part of a protein phosphoric acid complex that must be broken down before the pure vitamin can be obtained.

Food Sources. Food sources of riboflavin are less completely known than are sources of the other vitamins so far discussed. This is due partly to its later discovery but largely to the lack of a satisfactory method of measurement.

Milk, eggs, and lean meats are the richest sources. The yolk and the white of eggs contain it in about the same concentration. As riboflavin occurs associated with protein, it is present in milk in the skimmed milk and not in the butter fat.

In plants, riboflavin seems to be concentrated in the green parts. Thin green leaves are especially rich sources. Green stems are much

richer than the flower or the root. Although the vitamin is more concentrated in the green parts, the bleached parts of plants are not devoid of it, as they are of vitamin A. Most root vegetables and tubers contain some riboflavin. In fact, riboflavin is present in practically all vegetables of one sort or another.

Seeds vary considerably in the amounts of riboflavin they contain. Legumes, peas, beans, and especially soy beans are good sources, while nuts and cereal grains are not so rich. The germ portion of the seed usually contains a high concentration of riboflavin, as it does of vitamin B₁.

In general, fruits are low in their content of riboflavin. The majority can be rated only fair and some fruits such as grapes, lemons, oranges, and grapefruit, contain little more than a trace. If there is a basis for classifying fruits as to riboflavin content it is not apparent in the few data now available.

Fats and oils have already been described as not containing the water-soluble vitamins B₁ and C. They are also about the only foods that do not contain at least traces of riboflavin.

Losses of Riboflavin. There is not a great deal of information available on losses of riboflavin in foods. From the fact that the vitamin is soluble in water it might be anticipated that there would be loss during boiling or any process where food is kept in contact with water for any length of time. It will be remembered, however, that in foods riboflavin is combined with other substances. The difficulty experienced in removing the vitamin from foods by those who have undertaken quantitative estimation by chemical tests indicates that probably no great amount would be removed during boiling, blanching, or soaking.

Riboflavin is described as heat stable which again might lead one to think that losses during cooking would be small. Milk whey, having an acidity comparable to that of tomato juice, was found to lose only 10 per cent of its riboflavin value when heated at the boiling point of water for one hour, and four hours of heating was required

to reduce the original value by 30 per cent. When the mixture was made only slightly alkaline, the rate of destruction reached 30 to 40 per cent for one hour of heating. This is a clear indication that conditions within the medium influence inactivation of riboflavin as they do inactivation of vitamin B₁. Under similar conditions, in a liquid medium the rate of destruction of riboflavin was found to be slightly less than the rate of destruction of vitamin B₁. This relieves the situation relative to lack of specific information on loss of riboflavin in foods, since any measures designed to reduce losses of vitamin B₁ during boiling apparently would also operate to protect against losses of riboflavin.

In contrast to vitamin B₁, riboflavin is less stable when heated in a dry mixture than in one that is watery or even only moist. This may afford partial explanation of the fact that the most extensive losses noted have been in the baking, roasting, and frying of meats. These ranged from 30 to 60 per cent.

There is no indication that storage causes loss of riboflavin irrespective of whether foods are fresh, canned, or dried. Canning *per se* does not seem to reduce the riboflavin content of foods or at least not significantly. Information on the effect of drying is not available.

NICOTINIC ACID (PELLAGRA-PREVENTING FACTOR)

Properties. Nicotinic acid is a white crystalline substance soluble in water and fairly resistant to heat. The amide, nicotinamide, is also effective as a pellagra preventive. Like some of the other vitamins discussed, nicotinic acid as present in foods is combined with other substances and is not easily removed until these complex compounds are broken up.

Food Sources. No consistent effort has been made to determine the nicotinic acid content of foods accurately. Most of the studies along this line have been concerned with determination of pellagra-preventing value directly. Some of these studies have been made with dogs as subjects and some with human beings. It is difficult to

correlate the two kinds of data. Appraisal of pellagra-preventing value of foods on the basis of content of nicotinic acid depends upon the quantity of this substance required for the cure and prevention of pellagra; and this has not yet been definitely determined, although it can be stated approximately.

Milk, lean meats, eggs, fish, liver, and some vegetables have long been known to be valuable in the cure and prevention of pellagra. Among the vegetables, green leaves are especially effective, and the legumes (peas and beans) and tomatoes have some value.

Losses of Nicotinic Acid. The pellagra-preventing value of foods is not reduced easily. Foods have been heated in an autoclave or pressure cooker as long as six hours without showing a decrease in effectiveness. Canned foods seem to be equally as good as the corresponding fresh ones.

VITAMIN K (THE ANTIHEMORRHAGIC VITAMIN)

Properties. Vitamin K is one of the newer vitamins. It is a colorless or slightly yellowish crystalline substance soluble in fats but not in water. It seems to be resistant to heat but is destroyed by alkalis and certain substances that bring about oxidation.

Food Sources. Vitamin K is fairly widely distributed in foods. It occurs abundantly in green leaves, alfalfa having been one of the chief sources from which concentrates have been prepared. Flowers, roots, and stems of plants contain less than leaves. The vitamin is present in soy bean oil and some other vegetable oils and in tomatoes. It is not present in fish-liver oils, but decomposed fish meal has been the source of a substance having vitamin K activity, differing slightly from the vitamin K of alfalfa. A number of compounds are known to have properties ascribed to vitamin K but how many of these occur naturally is not known.

VITAMIN E

Properties. Vitamin E activity is shown by several substances. The one of most importance from the standpoint of its natural occur-

rence is alpha-tocopherol. This has been separated from wheat germ oil and cotton seed oil as a light yellow viscous oil.

Food Sources. Vitamin E occurs in many of the various types of foods considered essential in a well-balanced diet and it is not difficult to obtain an adequate supply. Foods known to contain vitamin E in abundance are milk; meat; eggs; whole seeds, including both cereal grains and legumes; and lettuce. It is also present in many vegetable oils including, in addition to the two already mentioned, corn oil, rice oil, and Red Palm oil.

Losses of Vitamin E. Vitamin E is soluble in fat and occurs associated with oils. It is stable toward heat but is inactivated when oils containing it become rancid—presumably because of oxidation.

VITAMIN B₆ OR PYRIDOXINE

Properties. Vitamin B₆ is a white crystalline substance and is soluble in water. It is stable toward heat even in alkaline solution, but is destroyed by long exposure to light.

Food Sources. Vitamin B₆ is found in seeds; in some vegetable fats and oils such as linseed oil, peanut oil, rice oil, soy bean oil, cotton seed oil, corn oil, and wheat germ oil; and in butterfat; beef fat; meats; and fish. Most vegetables and fruits are poor sources.

THINGS TO REMEMBER

The array of information relating to the vitamins is extensive and complex. Unless one is making almost constant use of it, it is next to impossible to keep even the essential details in mind, and very few people wish to be hampered by the need of a pocket handbook in order to remember their vitamins. In the selection and preparation of foods for a diet adequate in vitamin content a few rules or summary statements are usually sufficient. Those given below are suggested as helpful and others may be formulated if need requires.

1. Use a variety of all types of foods giving especial attention to the use of milk, eggs, green leafy vegetables, *fresh* fruits and vegetables, lean meats, and whole grain cereals and breads.

2. To avoid loss of vitamin value in cooking:

Cook foods as quickly as possible.

Use small amounts of water and use any that is left. Special utensils are not necessary for so-called waterless cookery.

Steaming is an excellent way to cook many vegetables and some other foods.

Do not peel vegetables or fruits and cut them up and then let them stand before cooking. Cooking them whole and with the outer covering on helps preserve vitamin content.

Never add soda to vegetables during cooking. It serves no useful purpose and makes for destruction of vitamins. Cook green vegetables in an open kettle and they will stay green.

Serve foods as soon as possible after they are cooked.

Do not fry foods if they can be cooked in some other way. Frying and roasting are very destructive of vitamins.

3. Give very careful attention to sources of vitamin B₁ in the diet.

It is more difficult to obtain an adequate amount of this vitamin than any of the others. It is probably the one in which American diets are most deficient. Take special care to conserve the vitamin B₁ in foods during cooking. Many of the foods that contain an abundance of vitamin B₁ are cooked before being eaten and next to vitamin C, vitamin B₁ is the vitamin most likely to be lost when foods are cooked or canned. The precautions necessary to conserve vitamin B₁ will conserve other vitamins as well.

4. Store foods at low temperatures and in closed containers.

5. Do not chop or crush fresh fruits and vegetables and allow them to stand. They lose vitamin C rapidly.

6. Frozen foods have practically the same vitamin content as fresh ones. Care must be taken to conserve it during preparation for serving. Do not defrost and then allow to stand. If frozen foods are to be cooked put them on to cook while they are still frozen and use all of the liquid.

7. Dried foods are not especially recommended for vitamin value.

8. Canned foods retain vitamin value well, with the possible exception of vitamin C, provided they have not been stored too long. To obtain full value, use the entire contents of the can. Canned foods are cooked foods and should be treated accordingly.

9. In canning foods observe the same precautions for conserving vitamin content as suggested for cooking.

VITAMIN VALUES

As soon as the existence of any one of the vitamins was recognized it became a matter of concern to know not only in what foods it occurred but also in what quantities. The development of methods of measurement was, therefore, of considerable importance. Chemical identification of the vitamins has usually not been made until some time after their discovery and for this reason development of chemical or physical methods of measurement proceeded uncertainly.

Many of the studies on the physiological effects of the vitamins have been made with laboratory animals. It was natural in some of these studies for information to be obtained on the relation between the quantity which an animal ate of a food known to contain a particular vitamin and the response of that animal in terms of growth or cure or prevention of the disease associated with the vitamin. As these observations were made, consideration was given to the possibility of using a relationship of this kind as the basis of a quantitative method of measurement for the vitamin concerned. Methods of determination in which the reactions of animals are used are called biological methods.

To determine actual vitamin content by a biological method it is necessary to carry out a test in comparison with a substance containing a known amount of the vitamin in question. When the biological methods were first suggested, this condition could not be met because the chemically pure vitamins had not yet been prepared and natural products vary too much to be used as reference materials. As a result of this situation it became the custom to express content with respect to a particular vitamin in terms of the quantity required to produce a given response in the animal used and under the conditions specified for the test. Such a quantity was known as a "unit." Several of these biological units have been defined and used but the best known are probably the Sherman units for vitamins A, B₁, and C, and vitamin G or B₂ (riboflavin).

As interest in the importance of the vitamins increased, attempts

were made to devise more satisfactory methods of evaluating them. A committee appointed by the Health Organization of the League of Nations has established standards of reference called International Standards of Reference for vitamins A, B₁, C, and D to be used in determining the content of these vitamins in foods and other materials. A definite *quantity* of each standard was specified as the International unit in terms of which the content of the respective vitamin was to be expressed.

*Definitions of the International Units for
Vitamins A, B₁, C, and D*

Vitamin A. The International unit of vitamin A is the vitamin-A activity of 0.6 microgram (0.0006 milligram) of the International Standard Beta carotene. One U.S.P. (United States Pharmacopoeia) unit of vitamin A presumably has the same value as 1 International unit (I.U.) of vitamin A.

Vitamin B₁. The International unit of vitamin B₁ is the vitamin-B₁ activity of 3.0 micrograms (0.003 milligram) of the International Standard crystalline thiamin chloride (vitamin B₁). One U.S.P. (United States Pharmacopoeia) unit of vitamin B₁ has the same value as 1 International unit (I.U.) of vitamin B₁.

Vitamin C. The International unit of vitamin C is the vitamin-C activity of 0.05 milligram of the International Standard crystalline ascorbic acid (vitamin C). One U.S.P. (United States Pharmacopoeia) unit of vitamin C has the same value as 1 International unit (I.U.) of vitamin C.

Vitamin D. The International unit of vitamin D is the vitamin-D activity of the International Standard solution of irradiated ergosterol in oil. One U.S.P. (United States Pharmacopoeia) unit of vitamin D presumably has the same value as 1 International unit (I.U.) of vitamin D.

Enumeration of vitamin potency in terms of International units is now the accepted mode of expression. As more satisfactory chemical and physical methods of measuring vitamin content are developed, this somewhat cumbersome device will doubtless be abandoned for the more usual procedure of giving composition on the

basis of weight of chemical substance. This is already the case with vitamin C where values are given more often in terms of milligrams of ascorbic acid per gram or per 100 grams of material than in terms of International units.

No International Standard for riboflavin has been established. The Sherman or Sherman-Bourquin unit is frequently used for denoting vitamin-G potency, otherwise riboflavin is given directly as milligrams or micrograms of riboflavin.

Values for vitamin-A, vitamin-B₁, and vitamin-C content of foods and other materials determined prior to the adoption of the International Standards of Reference are for the most part expressed in terms of the Sherman units. For some foods the only values available are expressed in these units and for this reason attempts have been made to derive factors showing the relation between the Sherman and the International units. Since there has been some divided opinion as to what these should be, it seems well to reemphasize the fact that a biological unit does not have an exact value. These units are defined in terms of animal behavior which, however well controlled, is certain to vary. This simply means that the ratio between an International unit and the corresponding biological unit varies according to conditions, and a fixed figure cannot be established for it. Values expressed in International units which have been derived from Sherman unit values by use of conversion factors cannot be considered more than rough approximations. International unit values so obtained should be clearly designated if presented with other material. The ratios given below for these two units represent general experience with comparative values.

Suggested Interrelation of Sherman Units for Vitamins A, B₁, C, and G and the Corresponding International Units

Vitamin A. Sherman units of vitamin A corresponding to 1 International unit of vitamin A have been found to vary from 0.8 to 2.5. The ratio of 1.5 is suggested as most representative, that is, 1 Sherman unit of vitamin A = 0.7 International unit.

Vitamin B₁. Sherman unit values of vitamin B₁ corresponding to 1 International unit of vitamin B₁ have been found to vary from 0.7 to 4 or 6 Sherman units. The most general relation for the majority of values obtained by the Sherman technique is suggested as 1 Sherman unit equivalent to 1 International unit.

Vitamin C. One Sherman unit of vitamin C is generally considered equivalent to 10 International units.

Riboflavin. One Sherman-Bourquin unit of vitamin G is equivalent to 3.0 to 3.5 micrograms of riboflavin.

VALUES FOR THE VITAMIN CONTENT OF FOODS

For some purposes, and especially for dietary calculations, it is desirable to have a set of values showing the quantities of the various vitamins in different foods. In the general discussion of food sources of the vitamins it was made clear that no food has a fixed and invariable content of any vitamin. Values for different samples of any food may vary over wide ranges depending upon the factors that influence the content of the vitamins it contains. The derivation of average values, in the strict sense of this term, is not possible without using an unreasonable amount of descriptive material concerning each individual food item. In lieu of this it might seem advisable to indicate a range in place of a single value. The difficulty in that case is that anyone requiring a single value will use the median of the range which may not be in any sense the best value to use. This reduces the problem to one of arbitrarily selecting what are considered the most representative values.

The values in the table presented here, which is offered as an aid to those who must use single values expressive of vitamin content, were selected on this basis. The selections were made from a summary of all of the data that could be obtained in the literature or elsewhere up to July 1, 1940. Careful consideration was given to the methods of analysis used and the nature of the food material studied. The values given should be taken as applying to foods that are reasonably fresh and of good quality. This is especially im-

portant to keep in mind relative to vitamin-C values. "Market fresh" vegetables are often far from "fresh" as far as vitamin-C content is concerned. Adjustments should be made in the vitamin-C values for fruits and vegetables, especially leafy vegetables, when the products to which they are being applied are not strictly fresh.

Some values in the table may differ materially from corresponding ones in other summaries. Too much concern should not be felt over such discrepancies, perhaps, since all values of this kind are, as explained, arbitrarily selected and their approximation to actual fact is problematical in any case. If specific information about a food is available, other values might be selected as more suitable.

Table 1. Values selected as representative of the vitamin A, vitamin B₁, vitamin C, vitamin D, and riboflavin content of common foods. Unless otherwise stated, the values given are for the edible portion of the fresh food.

FOOD MATERIAL	VITAMIN A	VITAMIN B ₁	VITAMIN C	VITAMIN D	RIBOFLAVIN VITAMIN G
	Units per 100 Grams ¹				
	Int.	Int. ²	Int. ²	Int.	Sherman ⁴
Alfalfa leaf meal, dried	8,000				500
Almond	75	75			200
Apple	75	15	(30-400) Av. 100		10
Apricot, fresh	4,000	10	100		17
Apricot, dried	5,000	30	60		35
Artichoke, Globe	200	60	175		Fair
Artichoke, Jerusalem		50	115		
Asparagus, green	700	70	700		40
Asparagus, bleached	0-50	50	650		Fair
Avocado	100	30	400		30
Banana	300	15	200		30
Barley	0	120	0		3
Beans, snap					
Green	1,000	25	300		40
Wax	0	25	300		40
Beans, shelled					
Lima	500	115	600		100
Runner	1,000	100	500		
Soy bean	200	125	800		100
Beans, shelled, dried					
Lima	100	175	0		300
Navy	0	170	0		
Red Kidney		150	0		
Soy bean	100	400			300
Beef, lean	50	40	0		75
Beet	0	15	100		10
Beet Tops	Excellent		1,000		150
Blackberry	150	15	140		

FOOD MATERIAL	VITAMIN A	VITAMIN B ₁	VITAMIN C	VITAMIN D	RIBOFLAVIN VITAMIN G
	Units per 100 Grams ¹				Sherman ²
	Int. ¹	Int. ²	Int. ³	Int.	
Black-Eyed Peas—see Cowpeas					
Blueberry	100	15			
High bush			120		
Low bush			90		
Brazil Nut	10	350			
Bread					
White	Trace	20	0		0
Whole Wheat	Trace	100	0		30
Rye	Trace	70	0		
Broccoli, entire plant	9,000	37	1,400		75
Flower	5,000	45	2,000		80
Leaf	16,000	45	2,500		150
Stem	1,000	25			
Brussel Sprouts	200	60	1,500		
Buckwheat		150	0		
Butter, average	2,400		0	80	
From cows on dry feed	1,200		0	40	
From cows on green feed	4,000		0	150	
Cabbage, head					
Young, partly green	100	25	1,200		30
Mature, bleached	0	25	1,200		15
Red			1,200		
Chinese	2,000	25	800		15
Cantaloupe	300	20	600		20
Carrot	2,100	20	100		20
Cauliflower	30	50	1,500		35
Celery Stalks					
Green	1,000	10	100		10
Bleached	10	10	100		
Chard	9,000	Fair	750		30
Cheese					
Cheddar	2,000	15	0		250
Cottage	500		0		Good
Cream	2,100		0		60
Cherry	15-550	15	200		
	Av. 200				
Chicken, Muscle					
Dark		50			Excellent
Light		30			Excellent
Clam	14	7			
Codfish	5	30	0		Good
Cod Liver Oil	*	0	0	*	0
Collards	7,000	50	800		100
Corn, Sweet					
White	0-50	45	200		
Yellow	500	45	200		20
Corn, dried					
White	0	100	0		Fair
Yellow	550	100	0		Fair
Corn Oil, refined	0	0	0		0
Cottonseed Oil, refined	0	0	0	0	0
Cowpea, fresh			130		
Dried	50	300			100

FOOD MATERIAL	VITAMIN A	VITAMIN B ₁	VITAMIN C	VITAMIN D	RIBOFLAVIN VITAMIN G
	Units per 100 Grams ¹				
	Int.	Int. ²	Int. ³	Int.	Sherman ⁴
Cranberry	20		225	0	0
Cream, 20 per cent	600	10		Traces	
Cucumber	20	15	200		8
Currant, Black	400	10	3,000		
Red		15	900		
Dandelion	12,000		2,000		Good
Dates, cured	150	25	0		15
Dock, leaves	14,000				Good
Egg, whole	1,000	50	0		110
White	0	0	0		100
Yolk	2,800	140	0		115
Eggplant	35	15	200		10
Endive (Escarole)	15,000	28	400		40
French	Good	25			20
Fig, Fresh	50	25	30		15
Dried	60	22	0		25
Flour					
White, patent	0	30	0		
Whole Wheat		160			Fair
Garden Cress	Excellent	30			
Gooseberry			500		
Grape	Trace	15	60		8
Grape Juice			30		
Grapefruit	0	23	850		Trace
Juice	0	25	900		Trace
Canned	0	25	800		Trace
Guava	200	14	1,500		3
Haddock	5	5	0		Good
Halibut		30			
Hazelnut	100	220			
Heart					
Beef	Trace	200			300
Lamb	Trace	200			
Pork		180			
Honey	0	0	0	0	0
Horseradish			2,000		
Huckleberry			800		
Kale	20,000	50	2,500		200
Kidney, beef or veal	1,000	60			700
Lamb	1,000	75			
Pork		150			
Kohlrabi		20	1,200		
Lamb, muscle, lean		80			70
Lard	4	0		0	0
Leek	Fair	50	400		Fair
Lemon Juice	0	10	900		Trace
Lentils, dried	Trace	170	0		105
Lettuce, green	4,000	25	250		75
Bleached	100	25	250		15
Romaine or Cos	800				30
Lime Juice			750		
Liver, Beef	9,000	75	Fresh	45	600
			750		

FOOD MATERIAL	VITAMIN A	VITAMIN B ₁	VITAMIN C	VITAMIN D	RIBOFLAVIN VITAMIN G
	Units per 100 Grams ¹				
	Int.	Int. ²	Int. ³	Int.	Sherman ⁴
Liver, Calf	7,000	70	Fresh 650	15	550
Chicken	Excellent	75	Fresh 450	50	Excellent
Lamb	Excellent	75	Fresh 750	20	550
Pig	Excellent	100	Fresh 525	45	600
Mango	1,500	30	600		20
Milk			Raw 40		
Whole Fresh, average market	110	20	Past. 25	2	75
From cows on dry feed	55	20	Raw 30	1	60
From cows on pasture	175	20	Raw 50	3	80
Whole Dried					
Average	875	120	0	16	500
From cows on dry feed	450		0	8	
From cows on pasture	1,400		0	24	
Skim	2	15	0		Excellent
Skim, dried	20	120	0		600
Molasses	0	0	0		
Mushrooms	0	30	Trace		
Mustard Greens	Excellent	45	2,500		Excellent
Oats (rolled or Oatmeal)	Trace	180	0	0	35
Okra	400	40	400		Fair
Olive, canned					
Green	190		0		
Ripe	125	2	0	0	0
Olive Oil, refined	0			0	
Onion, green	Fair		275		
Mature	0	10	160		30
Orange Juice	45-350	30	450-1,200 Av. 900		5
Oyster	140		5		
Papaya	2,500	25	900		60
Parsley	30,000		2,000		
Parsnip	Trace	40	450		
Pea, green, fresh	1,000	140	500		65
Green, dried	1,200	175			100
Peach, White	5	10	200		
Yellow	1,000	10	200		20
Yellow, dried	3,000		0		
Peanut, Jumbo	0	320			Good
Roasted		90			
Spanish		300			250
Spanish, roasted		60			
Pear	10	15	50		20
Pecan	400	350			100
Pepper, Green	5,000	10	2,500		40
Red	5,000	10	3,000		
Pineapple	90	25	500		12
Juice, fresh		30	600		
Juice, canned		25	300		

FOOD MATERIAL	VITAMIN A	VITAMIN B ₁	VITAMIN C	VITAMIN D	RIBOFLAVIN VITAMIN G
	Units per 100 Grams ¹				
	Int.	Int. ²	Int. ³	Int.	Sherman ⁴
Plum		35	100		15
Pork muscle, lean	Trace	400			75
Potato, average	30	40	250		15
New			350		
Stored, old			100		
Prune, fresh	1,500	20			
Dried	2,500	50	50		Good
Pumpkin	2,500	15	60		15
Quince			250		
Radish	Trace	20	400		10
Raisin	50	30	0		
Raspberry		10	600		
Rhubarb	Trace		400		
Rice, Brown	Trace	75	0		50
Polished	0	10	0		Trace
Roe	2,000	30	100		Fair
Rutabaga, White	0	15	400		
Yellow	25	15	400		
Rye	0	140	0		Fair
Salmon, canned					
Chum	30			225	
Chinook	750			275	
Pink	100			625	
Red	325	Trace	0	800	75
Sardine		10		Good	Good
Soy bean—see under Bean					
Spinach	25,000	40	1,500		125
Squash, Summer	1,000	15			15
Winter	4,000	15	100		25
Strawberry	Trace	Trace	1,000		Trace
Sweet Potato	3,500	30	400		30
Tangerine		30	700		10
Tomato, mature, Green	700	23	260-600		15
Ripe	1,000	25	Av. 450 260-600		20
Juice, fresh	1,000	25	Av. 450		
Juice, canned commercial			Av. 450 150-575 Av. 375		
Turnip, White	0	12	600		12
Yellow	20	12	600		12
Turnip Greens	10,000	40	3,000		120
Walnuts, Black	130	110			
English	100	150			
Watercress	4,000	40	1,500		90
Watermelon	Trace	20	150	0	10
Wheat	Trace	180	0		35

¹ Where there are no values, data were not available for making estimates. One hundred grams is approximately 3.5 ounces.

² International units of vitamin B₁ multiplied by 3 give micrograms of thiamin.

³ International units of Vitamin C multiplied by 0.05 give milligrams of ascorbic acid.

⁴ For the calculations made in this table, the relation of one Sherman unit equivalent to 3.0 micrograms (0.003 milligrams) of riboflavin was used. Sherman units multiplied by 3 give micrograms of riboflavin.

* For vitamins A and D use values given on the container.

SELECTING FOODS TO MEET VITAMIN REQUIREMENTS

In planning or assessing diets for adequacy in vitamin content, it is obviously necessary to have information as to the quantities of each of the vitamins needed in the daily diet. Suggested values for vitamins A, B₁, C, D, and riboflavin are summarized in Table 2.

At the present time considerable interest is being shown in studies to determine the requirement of the various vitamins known to be essential in the diet of man. The main problem has been the development of methods giving results that could be interpreted in relation to nutritional well-being. The first knowledge of the requirement of any vitamin came as a result of determining the quantity required to cure or prevent the disease associated with that vitamin. Such quantities have usually been referred to as mini-

Table 2.¹ Values suggested as expressive of the daily requirement for vitamins A, B₁, C, D, and riboflavin.

VITAMIN	FOR THE AVERAGE ADULT UNDER AVERAGE CONDITIONS			DURING PREGNANCY AND LACTATION	FOR GROWING CHILDREN AND ADOLESCENTS
	Absolute Minimum	Adequate	Optimum		
A	2,000 I.U.	3,000 to 5,000 I.U.	6,000 to 8,000 I.U.	more	8,000 to 10,000 I.U.
B ₁ (thiamin)	200 I.U. or 0.6 mg.	300 to 400 I.U. or 0.9 to 1.2 mg.	500 to 600 I.U. or 1.5 to 1.8 mg.	several times allowance for average adult	considerably more in proportion to their weight than adults
C (ascorbic acid)	20 to 25 mg. or 400 to 500 I.U.	40 to 60 mg. or 800 to 1,200 I.U.	80 mg. or 1,600 I.U.	twice that for the average adult	only slightly less than that for adults
D	not known			800 I.U. suggested as adequate	300 to 400 I.U. suggested as adequate for protection against rickets; 675 I.U. suggested for optimum growth
Riboflavin (vitamin G)	approximately 600 Sherman-Bourquin units or 2 milligrams				at least 400 Sherman-Bourquin units

¹ Previously published. Munsell, Hazel E.: Planning the Day's Diet for Vitamin Content. *Journal of the American Dietetic Association*, October, 1939, 15, p. 639.

mum protective quantities. It soon became apparent that the quantity needed for normal nutrition was considerably in excess of the minimum protective quantity. As information and experience accumulated the aim has been to obtain values of vitamin requirements that apply more nearly to normal nutrition.

In summarizing data on vitamin requirements, it seems desirable to give the quantities determined as minimum as well as those considered adequate. In some instances data have been obtained indicating that nutritional well-being is enhanced by a diet supplying quantities of a vitamin in excess of that considered adequate. Such quantities have been designated as optimum.

Studies to determine the requirement of the various vitamins are still in the preliminary stage. It is problematical whether the requirement of any vitamin can ever be expressed with precision. Many factors operate to influence the quantity of each that is needed. Data already at hand indicate that the requirements may vary from individual to individual according to sex, age, size, and activity, and vary in the same individual from day to day depending upon the physiological condition, activity, or environment.

The material offered in Table 2 should be used with certain considerations in mind. With the exception of vitamin D the values for the requirement of each of the vitamins represent quantities that may be supplied readily by the use of natural foods. These quantities indicate the *daily* requirement of the *normal* individual with no allowance made for variation in the vitamin value in different foods or losses that may occur from cooking or other processes to which the food may be subjected.

There is no evidence of harm from the ingestion of vitamins as they occur in foods in quantities considerably in excess of those given as requirements. In planning diets the aim should be to provide foods that will supply at least as much and preferably more than the adequate allowance of each vitamin and several times this allowance in cases where there is indication of a greater need.

THE AGING POPULATION AND PROGRAMS OF SECURITY

EWAN CLAGUE¹

THE aging population and programs of security is a subject which can be discussed under two main heads. One is the problem of old-age dependency, which is essentially the problem of the age group 65 years and over, although there are those who think the critical age might drop to age 60 or 55. The second problem is that of unemployment, the long-time, perennial problem of unemployment, which I would regard as primarily centering in the group aged 45 to 64.

I. OLD-AGE DEPENDENCY

EXTENT OF THE PROBLEM

The first topic, then, will be the dependency problem of old age. In that respect, I think the future does not offer us much more than the past has, namely, that an overwhelming proportion of the persons that reach old age will be dependent in one respect or another. In fact, I think I may say that the outlook is even worse than it has been in the past, because some of the sources of support for dependent old age which we have had in the past will be no longer present in the future.

In general, it seems to me there are three types of private sources of support in old age. One, of course, is work: a person supporting himself after 65 by some kind of productive employment. A second would be independence, or the building up of savings during the working life. The third would be dependence on relatives and children.

For the future it seems to me that the outlook for independent

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support through work is getting steadily less likely. On the farm, and in the rural economy generally, there is some prospect of the older person being productive enough not to be a burden upon the family group with which he is associated. In the urban economy, which is fundamentally the cash economy of the market, the older worker has little chance of obtaining employment so as to obtain wages through regular employment in industry; and, on the other hand, he constitutes a cash outlay for the family with whom he lives. Therefore, generally speaking, the prospect of his supporting himself in the urban economy is very much less than on the farm; he cannot do regular work in competition with younger workers, and there aren't the part-time opportunities for work that there are on the farm. I expect fewer and fewer of these people to be engaged in work of any kind. There may be some development in the future that will offer some hope in that respect, but right now I do not see any possibilities. So I believe that support through work will not be of major significance in the years ahead.

So far as savings are concerned, the number of persons who reach independent old age through savings has never been exceptionally large. I hesitate to suggest fractions of the population who have achieved that state in the past or will in the future; but I would suggest that something of the order of magnitude of 10 or 20 per cent would be a fairly liberal estimate. I would not look for very much improvement in that respect in the future.

The third source is dependence on children, and there the outlook is very dark indeed. In the past, with families of six, eight, or ten children, the support of parents was a relatively minor economic problem, especially when it was associated with farm living. In the future, with these one, two, or three-child families, it is clear that the burden of the aged becomes a very heavy one upon the producing members of that family. The burden becomes serious; the young-old ratio becomes almost one to one; that is, say, two or three dependent aged parents for every married couple.

Such a situation creates financial problems for the younger generation, and will greatly lessen the possibility of supporting the aged by their children, which has been the outstanding method in the past.

Consequently, so far as we can now foresee, support for the aged population through normal methods of the past—through work, savings, or dependence on relatives and children—is going to be very much less effective. The result is the emergence of the social problem of the dependency of a vast number of aged persons.

Now, before I go briefly into the possible solutions to that problem, I would like to touch on an aspect of it which should give us a good deal of thought. That is the political aspect. For this purpose I would like to draw on Dr. Thompson's figures. According to his medium estimates for the year 1980,³ the age group 20-44 will comprise less than 35 per cent of the entire population. This age group can be regarded roughly as the younger voting population. On the other hand, the estimates show that approximately 20 per cent of the entire population will be 60 years of age and over. About 40 per cent of the population will be 45 years of age and over. In other words, the estimates for 1980 show an actual majority of voters comprised of persons who are old or approaching old age. When we recognize that already the pension groups in this country are thinking in terms of age 60, sometimes 55, and occasionally, age 50, we can readily see that the pension movement can reach down and pick up enough of the voting population in the not-too-distant future to constitute an absolute majority.

Under these circumstances, we should recognize that the old-age movements of the present are in their political infancy; they are insignificant in power today compared to what they will be in the future. That, I think, is one of the most important political considerations that will face this country in the next forty years. In

³Thompson, Warren S.: Outstanding Population Trends Affecting Problems of Social Welfare. *The Milbank Memorial Fund Quarterly*, July, 1940, xviii, No. 3, p. 193.

fact, I would like to make the prediction that all the other problems that face us at the present time—capital and labor, agriculture, monopoly, possibly even foreign relations—will be dwarfed in the future by the problem of the aged. Programs of handling the aged are likely to be the outstanding political issue in every presidential election for many decades to come.

That also means, since the voting strength of these people is going to be so overwhelming, that unless we devise a social security system of old-age protection that has a reasonable chance of keeping them politically sane, they could easily wreck our economic system by their demands.

THREE METHODS OF HANDLING

The methods of handling this problem, as I see it, are three and I would like to discuss them very briefly: three types of security that we could provide for these older people. If we add the method of individual self-support and family dependence which we have had in the past, then we shall have four methods. This last method we have already taken up. It is sufficient here merely to state that there are persons who do build self-support for themselves in old age. There are those who will continue to do so. Thus, we may expect a minority of the population to have partial or complete self-support in old age in the future. The other three methods all involve community action.

(1) *Public Assistance on the Basis of Need.* One of these is old-age assistance; that is, public relief or assistance given to aged persons on the basis of need. That is the most cautious and conservative of community programs. It is one which at the present time aids about 25 per cent of the aged in the United States. There are about eight and a half million persons 65 years of age and over, and there are nearly two million receiving monthly payments in the States through the Federal-State program of old-age assistance now administered under the Social Security Act.

It is likely that this proportion will rise. It might go up to 30 per cent, it might climb to 40 per cent. However, it is essentially a program of supplementing private methods of old-age support. Therefore, it is the least costly, with expenditures at the present time running about half a billion dollars a year. These could rise, of course, to much higher figures. But this will always be a cautious, conservative program; it will always deal with a minority of old persons, because any genuine test of need which took into account not only the income of the aged individual himself, but also family responsibility, would probably insure that community attention would be devoted to a minority of the aged.

Since it supplements already-existing private support, it means that many of these assistance payments are partial; that is, they are supplementary amounts of five or ten dollars per month added to some income the person already has, or that his children will supply for him. This helps to keep the cost down. Assistance is a program which will take the worst edge off the problem, will meet the greatest need that exists, and will do the least damage to alternative private methods.

On the other hand, it is clear that assistance would constitute a rather limited attack on the problem of old age, and it is a serious question whether politically it would ever, in the long run, take the edge off the demands for much more liberal treatment of the aged. I do not believe that old-age assistance, useful as it is at the present time, and important as it might be in a period of dire financial stress, will satisfy the demands of the aged in the longer future.

(2) *The Free Pension Method.* The second method is at the opposite extreme. It is the free pension method, which in a way has grown out of our present old-age assistance. By free pensions I mean uniform, nation-wide, monthly pensions to all persons, without a needs test. That essentially is the Townsend plan, the General Welfare plan, and all the various state plans—"Ham and Eggs" in California, the Ohio plan, the Arkansas plan, and many others.

Generally, the state plans are conceived as models which can, if successful, be transferred to the federal level. The one basic characteristic of these plans is a uniform pension given to everybody of eligible age in the country, regardless of need.

That program has a great deal of appeal to many people, and I think that it is likely to grow in strength rather than decline in the future. It has the great virtue of simplicity—at least at first glance. It provides for federal administration, it avoids the needs test. I do not believe, however, that the uniform free pension program will be a satisfactory method of meeting this problem, chiefly because of the tremendous financial cost of it.

For that purpose, I would like to present a few figures. Recently the national income has been about seventy billion dollars per year. On a national income of seventy billions, Dr. Townsend's plan of \$200 a month for every person of 60 and over would cost roughly thirty billions; that is to say, it would take three-sevenths of the entire national income at the present time. If we drop down to \$50 a month for every person (60 and over), it would cost seven and a half billions a year; and there are a number of plans in prospect of about this order of magnitude.

There is another plan for \$60 per month per person or \$90 for an aged couple—which will average close to \$50 when the unmarried persons in the older age groups are taken into consideration. But even assuming \$45 on the average, the plan would cost six and three-quarters billion dollars a year to finance.

These figures should give an impression of the size of this problem right today. In contrast, our present expenditures for old-age assistance run less than half a billion dollars a year, and we are collecting in taxes for old-age insurance at the present time (with our tax of 1 per cent on employers and 1 per cent on employees) about six-tenths billion; so that the total of insurance and assistance is running about 1.1 billions per year.

Immediately upon the passage of one of these bills just described

(which wouldn't seem unreasonable to most people thinking in the abstract), we would be confronted with the difference between, say, 6.8 and 1.1, or an addition of 5.7 billions in taxes immediately. Furthermore, these figures do not take into account any of the age changes which Dr. Thompson has discussed. When there is taken into account the great increase in the proportion of the aged, when it is recognized that the present proportion over 65 years of age (about 6½ per cent of the population) will at least double in the next 40 years, it can be seen that this creates a financial problem of tremendous magnitude.

For lack of time, I shall not dwell at all on the tax aspects of ^{such} ~~such~~ plans. I could have devoted some attention to the various methods suggested for getting the money and what these might do to our economy. However, I shall just stop with the suggestion that the above data will give you some impression of the financial hazards that the nation and the community will face due to this problem of old age.

And that further emphasizes the unfavorable outlook for programs of public education and child welfare. It can be seen that education and children may have a hard time competing with the drive of this aged group, particularly in view of the political support the latter will have.

(3) *Contributory Old-Age Insurance*. The third suggestion is that of contributory old-age insurance. I am not going to spell out our present plan, or how we might modify that plan. I shall take for granted that you know substantially what it is. I merely want to give the philosophy of it and show why I think it is very important to have that kind of a system.

The significance of the contributory plan is that it ties together the contributors and the beneficiaries in the system. It doesn't give a free pension out of general revenue; it doesn't give to anybody something for nothing. In a free pension system the beneficiary may have only one interest, namely, to increase his share of funds

from the public till; and the taxpayer will also have but one interest, namely, to shut down on the revenue and somehow keep the beneficiaries from running off with his funds. The contributory system tends to tie together the taxpayer and the beneficiary into one and the same person.

To be very concrete, there isn't a person in this room, probably, who doesn't have some life insurance; you may have an endowment, built up in such a way as to provide support when you are old. I am doing that, and I suppose everyone else here is also. Not one of us thinks of that as a tax; we call it a premium that we pay for old-age insurance.

In another sense, as a member of the Civil Service Retirement system of the Federal Government, I am at the present time also paying $3\frac{1}{2}$ per cent of my salary regularly for old-age retirement. I do not count that as a tax. In my budget, it goes along with savings and insurance payments, which are considered as assets.

That, then, is the essence of a contributory insurance plan. It is highly socialized; it is not individualized, like private insurance. But, despite its socialization, it has the tremendous strategic, social, and political advantage of making the taxpayer today be, in part at least, the beneficiary of the future, and therefore makes each citizen voter who goes to the polls on election day a person who thinks both of costs and of benefits at one and the same time.

We have had a very interesting illustration of that in Washington in legislation on our Civil Service Retirement. Recently there has been a discussion down there among us as to what our payroll deduction shall be. There is one group who want it to stay at $3\frac{1}{2}$ per cent; these are the higher-salaried group, who do not stand to benefit much by paying 4 per cent or 5 per cent. On the other hand, the lower-salaried groups are eagerly pushing to have deductions of 4 or 5 per cent, because the benefits will then be liberalized and most of those benefits will flow to the lower-paid groups. What I want you to see is that the issues of costs and benefits are

kept closely interlocked, and therefore contributory insurance is a device for insuring that the voting population, at any time, takes account both of the present and of the future—thinks on the two sides at once.

I don't believe that it is going to be possible to maintain political sanity in this old-age field by any other instrument than this one of contributory old-age insurance; and, therefore, I think that the next five to ten years may be crucial in determining how well we shall manage our old-age problem in this country.

There is another point worth mentioning here. All kinds of groups, even conflicting groups, can get together around this kind of a welfare program. I might cite the fact that in old-age insurance some of the leading industrialists of the country are the most eager and enthusiastic supporters of this program. I need mention only Mr. Swope of General Electric, Mr. Stettinius of the United States Steel Corporation, or Mr. Folsom of Eastman Kodak Company. These industrialists can see the advantage of maintaining this kind of insurance relationship, which most closely resembles what we have in private life.

State Repet

I cite, then, the outstanding significance of contributory old-age insurance as the device for handling this old-age problem. It is a flexible system, as witness the fact that it is possible to adapt the payments to the situation of a beneficiary who wishes to return to regular work; we stop the benefit payments in the month in which a man works; but, at the same time, if he can work part of the year and then retire for the other part of the year, he can receive benefits when actually retired.

And lastly, of course, it can be supplementary to private activities of one kind or another. I believe the insurance companies are endeavoring to sell people annuities that will be additional to the levels of benefits that are provided by this system. The program will dovetail rather naturally with private and self-help efforts to build independent old age, although it, of course, has a strong

social trend in that it does give wide support to the aged through a socialized system of contributory insurance.

II. THE PROBLEM OF UNEMPLOYMENT

The second problem concerns the nearly-old. This group is that of age 45 to 64. The first problem would be summed up by saying that we must somehow maintain the dependent aged (65 and over) by some system that will prevent them from claiming the bulk of the national income. One method of doing that, of course, would be to hold firmly to a limit of 65 years of age for retirement purposes. If we extend the retirement age downward to people as young as 55 or 50 years of age, then no matter how cautious and conservative an insurance system we might adopt we would have an exceedingly difficult financial burden. The self-supporting population cannot take on an impossible task.

It is in this area that the second problem begins emerging—a problem of unemployment. This is not a problem of cyclical unemployment, not a problem of the ups and downs of prosperity and depression, but a problem of the long-run unemployment of this older group of workers. If they are not employed, they will be pension-minded; I think we may take that for granted. Unless we can somehow work out a system of absorbing this labor supply into reasonably full employment, they will add themselves to the dependent pensioners and intensify the latter problem.

Now, very briefly, let me sketch what I think are some of the industrial aspects of that problem. If we look back two hundred, three hundred years ago, we are safe in saying that the average worker who started out in life with an occupation could count upon using it throughout his life. In other words, industry changed very slowly; technological changes were relatively infrequent. The young guilds man of eighteen years of age who learned the trade of shoemaking would be a master craftsman in the same processes 30 years later.

In fact, the situation was even better than that. The average working span of life was shorter than it is today due to higher death rates. Under those circumstances we had a relatively quick turnover of the labor population. In, say, 25 years an employer had a practically new working force. And taking in conjunction the fact that industrial change occurred very slowly and infrequently, we can then realize the adaptability of labor to the job. It was a quick and constant adaptability, a matter of training youngsters all the time.

Now look at our situation today. We have lengthened the life of the average worker so that he is available for work over a period of 40-50 years. Thus, in terms of human beings, the labor turnover has been slowed down considerably. On the other hand, we have multiplied many times the speed of turnover of technological change. To make this more concrete, may I ask you to name a single occupation in the world today that you could guarantee would exist twenty years from now in about its present form? Nearly all occupations today are subject to some change, and in the more mechanical operations they are subject to rapid and spectacular change. Consequently, on the whole, industry is changing very rapidly while the labor supply is turning over relatively slowly.

This, then, is what we are up against. The average man learns a job at, say, twenty. He operates in that job, perhaps more or less successfully, through the first half of his working life. By the time he is forty-five, he may find that his occupation no longer exists, at least not in the way he learned it. Furthermore, in general, his industrial experience has been such that he hasn't been trained in other jobs while he was working. Some workers move about so much, either voluntarily or involuntarily, that they hold a great many different jobs and acquire a certain amount of adaptability, but, on the whole, industry does not automatically retrain its workers.

Therefore, half way through life, our modern worker may find

that his occupation has disappeared. Then he is faced with twenty years more, but with no occupation in which he is qualified. Under these circumstances, we can readily understand the unemployment that develops among these older workers. They drop out, not because of failure in themselves, but because of outside circumstances—industrial depression, bankruptcy of the firm, and many other such events. After that they cannot get back again; there are no openings in their old occupations and they have no training in any new ones.

I would like to add one other thought, and since there are some biologists here, I would like to have them consider it. In early life a person develops certain qualifications, capacities, skills, strength, speed, and so on, which are useful in an occupational way. In the forties there occur basic biological changes which alter these basic qualities. One no longer has the same capacity to do old things or to learn new things. Yet the fundamental question still remains, how can we get 20 years of productive work from the older worker?

That is the basic unemployment problem, as I see it, and I believe that the solution to it will in turn be closely related to the solution of our old-age dependency. I mean that the two problems must be solved coordinately, or else one or the other will overwhelm us.

I would like to indicate briefly some of the things which might be done. One of the previous speakers referred to education. To my mind the big educational problem of the future is, how can we take workers in the forties and retrain them for another twenty years of productive life? Suppose they did one kind of work in early life, went through a retraining process in the forties, and then became self-supporting through other work until they reached retirement at 65. That is the challenge to the educators of the future. And we in Social Security, through our employment service and some of our activities allied with education, see ourselves also involved in that program.

I believe further that unless this is done by the community, it

won't be done at all. Individual employers in private industry cannot run the risk of spending vast amounts of money for retraining, in the hope that they will be able to reap a return from the workers afterwards. Therefore, while we shall need the assistance and support of private industry, we must plan for this as a community enterprise.

A number of professions will have to be brought to bear at this point. Not only is it a question of training this worker for a new occupation, which means discovering occupations that would be possible for him; but it also means training him to be willing to perform these occupations. I don't see how we can avoid, for instance, full use of the social worker in this area, because one of the things that will have to be done is to get the worker in a different frame of mind about the kind of work that he can do, about the wages that he can make, and about his position in the social order. One of the reasons why these older people find it difficult to obtain work is that their attitude toward any new job is influenced by their former work experience. It is hard for a \$20-a-day man to reconcile himself to being a janitor at \$3 per day. Employers who hire such a man will not again repeat their mistake.

One last word and I am through. It seems to me that our society is becoming very much more atomistic. The connection between the earnings of producers and the distribution of goods to consumers is becoming more and more tenuous; the self-supporting wage-earners will be fewer in number; their dependents, whether more numerous or not, not tied as closely as fathers and mothers to their children, but rather tenuously connected in cousinships and more remote relationships. Consequently, the normal family methods of securing distribution of income from earners to consumers will be seriously weakened.

These community enterprises of the kind that I have been describing—the social insurances, the retraining programs, and the services of all kinds—are the only methods by which we shall be

able to distribute the products of industry reasonably among the people of this country. And unless we get some satisfactory method (and a conservative, cautious method at that) it seems to me that one or the other of these conflicting groups will run away with things and may wreck the economic system in the process.

In that respect, of course, I am an ardent advocate of social insurance as a device. I think it is a device that does not depart too much from our present private methods of operation. I think it retains a high measure of individual responsibility, and is, therefore, a likely method for avoiding that rigid control of our economic system which would otherwise be necessary in order to obtain the required distribution of goods to the masses of the people.

POPULATION TRENDS AND PROBLEMS OF PUBLIC HEALTH

GEORGE ST. J. PERROTT AND DOROTHY F. HOLLAND¹

THE scope and emphasis of a public health program are necessarily influenced by the changing characteristics of the population it serves. The rate of population growth affects long-range planning of community health and medical facilities. Alterations in age composition, internal migration of racial or industrial groups, changes in population density and urban-rural movement require current adaptation of the health program to solve the new problems thus created. Among the various characteristics of recent population trends, aging of the population is one of the most fundamental in its bearing on national health. The social and economic effects of an aging population have long been recognized. Dr. Louis I. Dublin appraised the problem of old age in some detail in 1926, when the provision of economic security for the aged was the dominant theme of contemporary discussion.² The passage of the Social Security Act in 1935 represented the fruits of the efforts of this early period.

Adjustment of national policy with respect to the health problems associated with aging of the population has been slower in development. Under the terms of the Social Security Act, a limited expansion of activities designed to promote the health of older adults—control of cancer and pneumonia, and industrial hygiene services—has been made possible in the cooperating States. How-

¹ From the Division of Public Health Methods, United States Public Health Service.

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The authors make grateful acknowledgment of the contribution of Bernard D. Karpinos, Assistant Statistician, United States Public Health Service, represented in the population forecasts utilized in this paper.

² Dublin, Louis I.: Chapter VII. The Problem of Old Age, an address presented at the 17th annual New York City Conference of Charities and Corrections, May 13, 1926. Published in *HEALTH AND WEALTH: A SURVEY OF THE ECONOMICS OF WORLD HEALTH*. New York, Harper & Brothers, 1928.

ever, the Act makes no provision for the solution of such fundamental problems as invalidity insurance and medical care of the aged. During the past five years, the health aspects of old age have received increasing attention in the discussions of public health administrators. It therefore seems appropriate to resurvey this general problem, and to consider, in particular, the nature of future trends in mortality, morbidity, and the receipt of medical care which may be expected solely as a result of changing age structure of the population.

THE EFFECT ON THE DEATH RATE

The effect of a declining proportion of children and an increasing proportion of "elders" on the future trend of the death rate may be readily predicated from the characteristics of age variation in mortality, which are generally familiar. The period of infancy is characterized by a large proportion of fatally terminating illnesses. Following the high mortality of the first year, the death rate declines rapidly in the succeeding years of early childhood, and the rate among children 5 to 14 years of age is lower than in any period of life. The age curve of mortality remains at a relatively low level in youth and the young adult ages. During the period of middle age, a marked upward trend in the death rate becomes apparent, and the increase thereafter is progressive. The sharp downward trend in the death rate following infancy, and the rapid rise which occurs during middle and old age are the most pronounced characteristics of age variation in mortality. The mortality rate in infancy and early childhood has shown a marked reduction in the present century, while the rate at the advanced ages has remained practically unchanged. Thus, the death rate at the older ages has shown an increasing relative excess over the rate in the early years of life. Furthermore, aging of the population has increased the number of older persons exposed to the chance of death. Deaths of persons 45 years of age and over constituted over two-thirds of all deaths in

this country in 1935; in the Registration States of 1900, the proportion was approximately two-fifths.

It thus results that the diseases which at present are the leading

Table 1. Distribution of population and deaths by age in the United States, 1900 and 1935.¹

Age in Years	Population		Deaths	
	1900 ²	1935	1900 ²	1935
	Per Cent			
ALL AGES	100.0	100.0	100.0	100.0
Under 15	29.5	27.3	34.6	13.9
Under 5	10.4	8.1	30.3	11.3
5-14	19.1	19.3	4.3	2.6
15-24	18.6	18.3	6.4	4.5
25-44	31.1	29.8	16.5	13.9
45-64	15.7	18.7	18.2	27.6
65 and Over	5.1	5.9	24.3	40.1

¹ Population, United States Registration States of 1900, from *Mortality Rates, 1910-1920*, Bureau of the Census, 1923, p. 654, and for the United States in 1935, from Special Release of the Bureau of the Census, Feb. 18, 1937. The number of children under 5 years of age in 1935 have been increased to allow for underenumeration, as estimated by Whelpton in National Resources Committee, *POPULATION STATISTICS, I. NATIONAL DATA*, Washington, D. C., October 1937. Deaths, 1900, from Special Reports, Bureau of the Census, *Mortality, 1900-1904*, and for 1935, from *ibid.*, *Mortality Statistics, 1935*.

² Population and deaths in the United States Registration States of 1900 (Connecticut, District of Columbia, Maryland, Maine, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Rhode Island, and Vermont).

and over) would be 120 per cent larger than in 1930 (and children under 5 years 13 per cent fewer), assuming no increase of the population through immigration, a moderate decline in the birth rate, and a gain of approximately eight years in the expectation of life at birth.³ It is apparent that aging of this magnitude would have a marked tendency to increase the death rate from diseases characteristic of middle and old age, and, in consequence, the crude death rate from all causes. Population analysts (Thompson and Whelp-

causes of death in the population of all ages are largely those characteristic of middle and old age. Diseases of the heart, cerebral hemorrhage, nephritis, cancer, and diabetes accounted for 65 per cent of the deaths among persons 45 years of age and over, and for 44 per cent of the total deaths among persons of all ages occurring in the period 1934-1936. Thompson and Whelpton estimate that by 1980, the number of persons in middle and old age (45 years

³ Thompson, Warren S. and Whelpton, P. K.: report included in *THE PROBLEMS OF A CHANGING POPULATION*. Washington, D.C., National Resources Committee, 1938.

ton,⁴ Dublin and Lotka⁵) have estimated the amount of increase which may be expected in the crude death rate as a result of aging, on the basis of varying assumptions concerning the future trend in fertility and the amount of decline in age specific mortality rates for all causes of death.

A precise estimate of the effect of aging of the population *per se* on future death rates from specific causes would involve a similar prediction of the future trend of age specific mortality rates from the diseases under consideration, and the application of these hypothetical rates to an estimated population in which survivals were determined by these rates. An undertaking of this nature was not practicable in connection with the preparation of the present report. However, the effect of changing age structure on the death rate from specific diseases may be broadly indicated by assuming that their age specific mortality rates undergo no future decline. A population has been constructed for the United States on the basis of such an assumption in regard to mortality (i.e., a continuation of age specific mortality rates as of 1929-1931) and a moderate decline in fertility.⁶ In 1980, children under 15 years of age would represent 21.2 per cent of this total estimated population, compared with 29.4 per cent in 1930; and children of these ages would number in 1980, 30.3 million, compared with 36.1 million in 1930. Persons 65 years of age and over would form 11.1 per cent of this estimated population in 1980, and number 15.9 million, compared with 5.4 per cent, and 6.6 million, in 1930.

⁴ Thompson, Warren S. and Whelpton, P. K.: *POPULATION TRENDS IN THE UNITED STATES*. New York and London, McGraw-Hill Book Company, Inc., 1933.

⁵ Dublin, Louis I. and Lotka, Alfred J.: *LENGTH OF LIFE*. New York, The Ronald Press Company, 1936.

⁶ The population was constructed by Karpinos according to the following method:

The population of the United States enumerated in the Census of 1930, distributed by five-year age groups according to sex and race, was taken as a base. "Other colored" persons, exclusive of Negroes, were included in the white population. Persons of unknown age were distributed proportionally in each sex-race group. The number of children under 5 years of age was corrected for under-enumeration on the basis of an estimate by Thompson and Whelpton, included in Table 1 of

(Continued on page 363)

The results of the application of the age specific mortality rates for selected causes of death as of 1934-1936 to this estimated population in future years are shown in Figure 1. The age specific death rates used in these computations are not included in this report, since the basic data are readily available in the publications of the Bureau of the Census.⁷

The dotted line in the chart indicates the percentage change in the estimated population between 1935 and decennial periods beginning in 1940. The percentage change in the number of deaths from all causes, and from each selected cause of death estimated on the basis of the respective crude death rates would be equivalent to that of the total population. Thus, taking into account only the increase in the total population, the number of deaths from each

POPULATION STATISTICS. 1. NATIONAL DATA. National Resources Committee, Washington, D.C. 1937.

For the white population, an average net reproduction rate of .980 for the period 1931-1935 was reported in *Population Index*, April, 1939, 5, No. 2, based on data supplied by the Statistical Bureau of the Metropolitan Life Insurance Company. From this rate taken as a base, a gradual decline in fertility was assumed in succeeding years, reaching a net reproduction rate of .870 in 1980. The assumed rate of decline in fertility corresponds closely with the "medium" fertility assumption for the white population made by Thompson and Whelpton, as stated in POPULATION STATISTICS. 1. NATIONAL DATA, referred to in the first paragraph above. For the Negro population, it was assumed that a net reproduction rate of 1.00 would prevail without change in the period 1930-1980. On the basis of these assumptions, the number of births in the total population would decline 12.4 per cent between 1935 and 1980.

Survivals based on the life tables for the United States, exclusive of Texas and South Dakota, 1929-1931, prepared by the Metropolitan Life Insurance Company, were used in the construction of the population, the life tables for Continental United States prepared by the Bureau of the Census having been published subsequent to the period when the basic computations for these population estimates were made.

The age distribution of this estimated total population in 1980 would be as follows:

Age in Years	Number (in Thousands)	Per Cent	Age in Years	Number (in Thousands)	Per Cent
Total	142,898	100.0	25-34	21,004	14.7
Under 5	10,034	7.0	35-44	19,940	14.0
5-9	10,103	7.1	45-54	18,254	12.8
10-14	10,202	7.1	55-64	16,769	11.7
15-19	10,288	7.2	65 and Over	15,927	11.1
20-24	10,377	7.3			

⁷ The annual reports on mortality statistics published by the United States Bureau of the Census (years 1934-1936) were used as the source of the data on deaths. An unpublished estimate of the population of the United States in 1935 by Bernard D. Karpinos was used in the computation of the death rates.

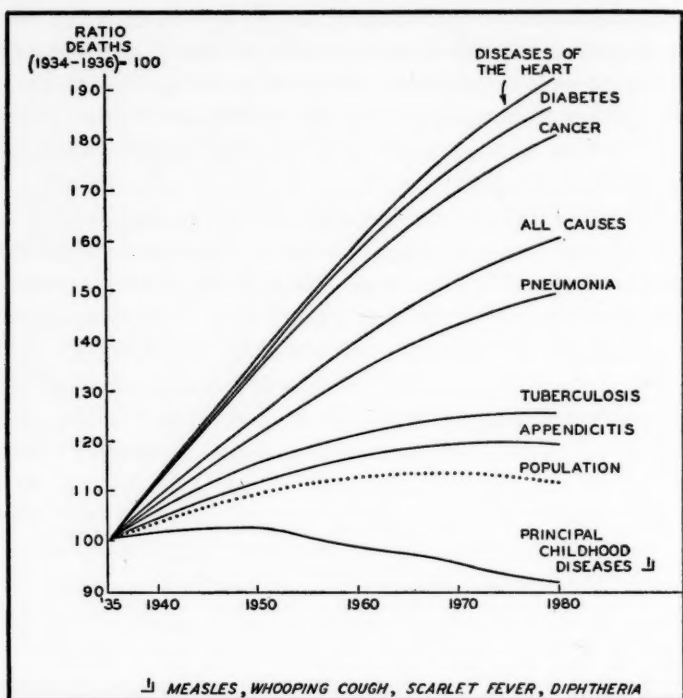


Fig. 1. Ratios of deaths from selected causes in the United States, 1940-1980, estimated on the basis of age-adjusted mortality rates, to deaths in 1934-1936. Diseases of the coronary arteries and angina pectoris are included with diseases of the heart. Cancer includes other malignant tumors. The designations pneumonia and tuberculosis relate to all forms of these diseases.

of the selected causes would increase 12 per cent between 1935 and 1980. However, if the age specific mortality rates for these causes of death were applied to the population constituted with respect to age as estimated for 1980, the increase would amount to 92 per cent in deaths from diseases of the heart, 80 per cent in cancer deaths, and 87 per cent in deaths from diabetes. The age variation in mortality from these diseases is similar, the death rates being relatively low prior to middle age and rising sharply thereafter.

The tendency of deaths from these causes to increase as the population ages is therefore marked, and of approximately the same order.

Future population changes among children, and, in particular, among children under 5 years of age, are reflected in the trend of deaths from the principal communicable diseases of childhood between 1935 and succeeding periods, estimated on the basis of age specific death rates. In the population as estimated, the number of children under 5 years of age would increase between 1935 and 1950 (the effect of a declining birth rate being offset by a continued increase in the number of women at the principal childbearing ages to the period 1945-1955) and deaths from the common communicable diseases of childhood would show a corresponding rise. A decline in the number of deaths from this group of diseases would accompany the numerical decline in children of these ages after 1950. Aging of the population would result in a relatively small increase in deaths from tuberculosis. The death rate from this disease reaches a high level at the early adult ages, and remains high in subsequent age periods. Thus, the decrease in tuberculosis deaths accruing from young adults, who would decline somewhat in the population of the future, would provide a counter-tendency toward the increase in deaths associated with the increment of older persons.

If the mortality rates of the life tables of 1929-1931⁶ are applied to the population of the United States in 1935 and 1980 distributed by age in accordance with the assumptions adopted, it is found that aging of the population in this period would result in a 61 per cent increase in deaths from all causes. In terms of the crude death rate, this change would represent an increase from a rate of the order of 11 per 1,000 in 1935 to an estimated rate of 17 per 1,000 in 1980. It is not probable, of course, that so marked an increase in the crude death rate will actually occur, since it seems reasonable to expect some reduction of the age specific mortality rates now prevailing.

THE EFFECT ON FREQUENCY AND DISABILITY RATES OF ILLNESS

Aging of the population may be expected to result in a relatively lower rate of increase of illnesses than of deaths. After the first year of life, the chance of death is relatively small until the periods of middle and old age are attained. While the incidence of illness shows a similar upward trend at the advanced ages, age variation in the incidence of illness and death presents striking differences prior to this period. In childhood, the mortality rate is high only in the first year, but high frequency rates of illness are observed through the first ten years of life. The incidence of illness falls sharply in late childhood and youth, yet the level of the frequency rate of illness in comparison with the death rate at these ages is relatively high. A further striking difference between the incidence of illness and death is seen in the young adult period, in which the age curve of illness shows a secondary peak, while the death rate, still at a relatively low level, is undergoing a slow increase from the minimal rate observed at ages 10 to 14 years.^{19, 20} Thus, changes in the structure of the future population prior to the period of middle and old age will have a significant effect on the future incidence of illness.

However, the aging factor should result in a material increase in the days of disability accruing from illness, since the average duration of illness increases progressively with age in a manner resembling the age incidence of death. The diseases which account for the high frequency of illness in childhood and the young adult period are typically short in duration. Thus, the disability rate is

¹⁹ Falk, I. S.; Klem, Margaret C.; and Sinai, Nathan: *THE INCIDENCE OF ILLNESS AND THE RECEIPT AND COSTS OF MEDICAL CARE AMONG REPRESENTATIVE FAMILIES*. Chicago, Illinois, The University of Chicago Press, 1933.

²⁰ Collins, Selwyn D.: A General View of the Causes of Illness and Death at Specific Ages. U. S. Government Printing Office, Washington, *Public Health Reports*, February 22, 1935, 50, No. 8.

²¹ Holland, Dorothy F.: Disabling Diseases of Childhood. *American Journal of Diseases of Children*, December, 1939, Vol. 58.

relatively low prior to middle and old age, when a rise occurs which is associated with the increasing incidence of chronic disease.^{10, 11}

The records of disabling illness obtained in the National Health Survey, a house-to-house canvass conducted by the United States Public Health Service in 1935-1936, provide a basis for estimating the effect of changing age composition of the population on the future incidence of illness and the volume of disability. The experience of 1,581,577 white persons in thirty-one cities of 100,000 population and over canvassed in this survey has been selected for this purpose.

The illnesses recorded had caused a minimum of seven consecutive days of disability, i.e., time lost from school, gainful or other work, or other usual activities, in the twelve months preceding the date of the canvass. The method and scope of the survey, and its broad results have been reported in earlier publications.^{10, 12, 13} In the interpretation of subsequent estimates based on data of the National Health Survey, it should be noted that the survey records relating to tuberculosis, mental disease and defect, cancer and syphilis are incomplete because of certain limitations inherent in the house-to-house method of enumerating illness. The informant may fail to include on the family roster persons confined in tuberculosis sanatoria, or in institutions for the mentally diseased or defective; or, because of long confinement (as of the mentally diseased or defective), such persons may have no family status. Inadequate or incorrect information concerning the diagnosis of cases of cancer and syphilis, or unwillingness to report such cases to the enumerator, probably accounts for the incompleteness of records of these diseases obtained from laymen. Under-enumeration of illness due to certain of

¹¹ Collins, Selwyn D.: Cases and Days of Illness Among Males and Females with Special Reference to Confinement to Bed. U. S. Government Printing Office, Washington, *Public Health Reports*, January 12, 1940, 55, No. 2.

¹² Perrott, George St.J.; Tibbitts, Clark; and Britten, Rollo H.: The National Health Survey: Scope and Method of the Nation-wide Family Canvass of Sickness in Relation to its Social and Economic Setting, U. S. Government Printing Office, Washington, *Public Health Reports*, September 15, 1939, 54, No. 37.

¹³ Britten, Rollo H.; Collins, Selwyn D.; and Fitzgerald, James S.: Some General Findings as to Disease, Accidents, and Impairments in Urban Areas. U. S. Government Printing Office, Washington, *Public Health Reports*, March 15, 1940, 55, No. 11.

these causes has been observed also in the results of the representative family survey made by the Committee on the Costs of Medical Care.²⁴

The nature of age variation in the frequency and disability rates of illness classified by cause observed in this population is shown in Appendix Table 1. The age specific rates shown here, except those relating to confinements terminating in live births, have been applied to the estimated population of the United States in 1935, and to the 1980 population estimated by the method outlined previously. The number of confinements terminating in live births has been estimated for 1935 on the basis of the live births actually registered in the United States in that year (increased to allow for under-registration), the resultant days of disability being estimated from the average duration as observed in the large cities canvassed in the National Health Survey. For 1980, the number of disabilities associated with confinement, and the days of disability associated therewith were reduced in accordance with the decline in the birth rate assumed in the construction of the 1980 population. The age specific frequency and disability rates of illness due to all causes except confinement cases were assumed to prevail at the same rate in 1980 as in 1935.

The results of these estimates of the future incidence of disabling illness and the resulting days of disability for illness of specific causes are shown graphically in Figure 2. If the number of disabling illnesses due to these specific causes increased at the rate of growth of the total population, a 12 per cent increase would represent the change between 1935 and 1980. However, the total increase in this period would amount to 56 per cent in cancer cases, 51 per cent in illnesses due to the degenerative diseases, and 41 per cent in illnesses

²⁴ The incomplete enumeration of institutional cases in the survey of the Committee on the Costs of Medical Care is indicated by the fact that the number of hospital days per capita recorded for patients in tuberculosis and mental hospitals in 1928-31 was .19. (See footnote 8.) On the basis of data in The Census of Hospitals of the American Medical Association relating to the year 1930, hospital days for patients in these institutions in the country as a whole amounted to 1.40 per capita.

due to rheumatism, on the basis of estimates which take into account the age specific frequency rates of illness due to these causes. In nervous and mental disease, the total increase would amount to 23 per cent. The effect of aging on the incidence of the group of nervous and mental diseases would be increased by a more complete representation of cases of insanity, but it is estimated that only 9 per cent of the illnesses included in the broad group of nervous and mental diseases as used here were due to this cause.²⁸ Underenumeration of the insane, usually residents of institutions, is a defect of the technic of the family survey.

On the other hand, the changed age structure of the population would result in no material increase in illnesses due to diseases of the respiratory system (exclusive of pneumonia, tonsillitis, and respiratory tuberculosis). Illnesses due to the communicable diseases (in the classification used here, largely those of childhood), tonsillitis, and disabilities associated with the puerperal state, would be fewer in number in 1980 than in 1935, due to the decrease in births and in the child population. Thus, several of the most frequent causes of illness would not be affected by the factor of aging *per se*. Furthermore, the large proportionate increase of illness due to the characteristic chronic diseases of middle and old age associated with aging of the population represents an actual increase of small magnitude in certain chronic diseases of low incidence.

The average age specific frequency rates of illness of all causes take these various factors into account. When these rates are applied to the estimated population in 1980, it is found that the total number of disabling illnesses would show no excess above the number expected on the basis of population growth. However, the total days of disability accruing from illnesses of this category would increase 31 per cent as a result of changing age composition, compared with a 12 per cent increase in the total population. The

²⁸ Based on the experience of 280,073 white persons in eight large cities canvassed in the National Health Survey. Comparable data for all cities of 100,000 population and over canvassed in this survey are not available.

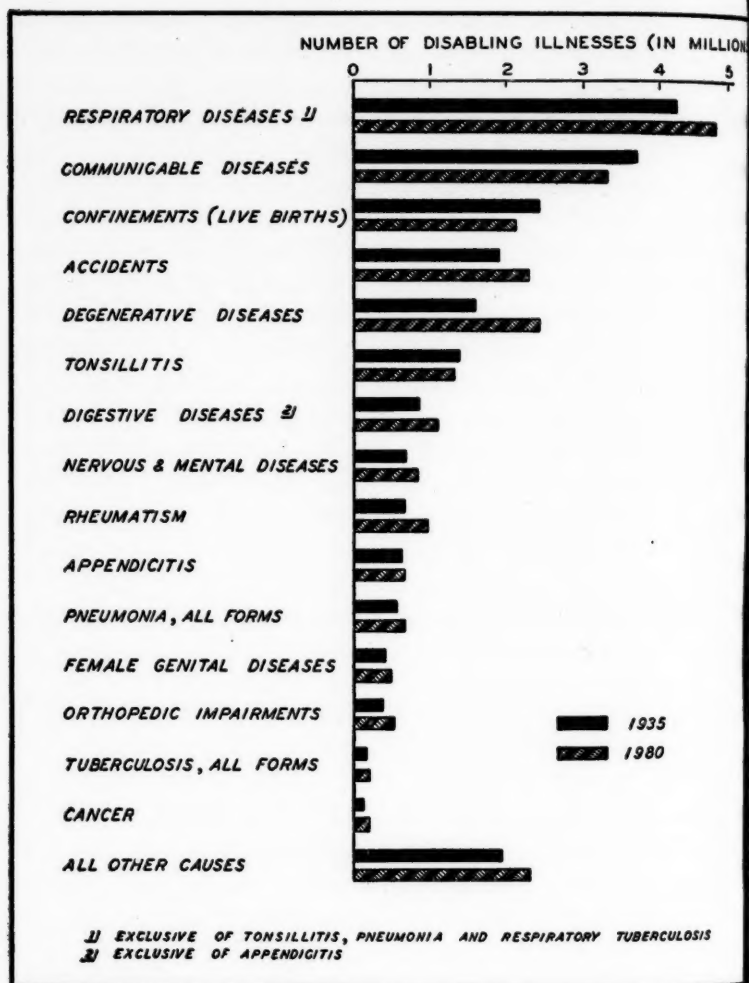
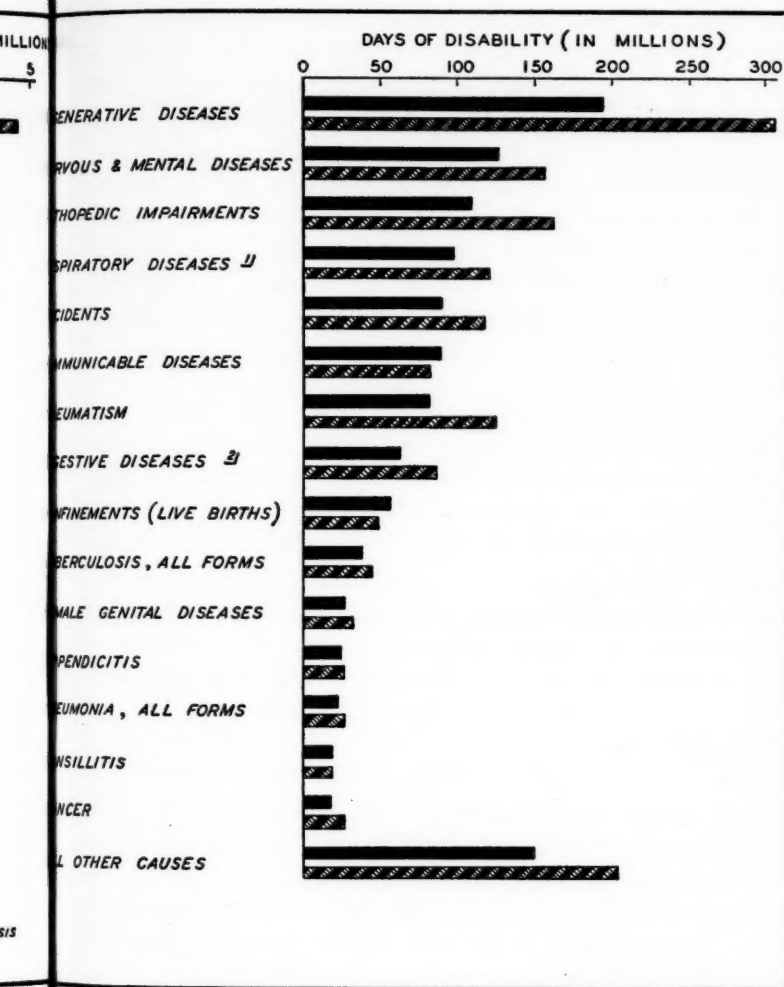


Fig. 2. Number of disabling illnesses and days of disability in a twelve-month period in the United States in 1935 and 1980 according to cause, estimated on the basis of the frequency and disability rates observed in cities of 100,000 and over



canvassed in the National Health Survey, 1935-1936, adjusted for age. (The method of estimating the data relating to confinements terminating in live births is described on page 375 of the text.)

notable difference between the effect of aging of the population on illnesses and the resultant days of disability arises from the difference in rank of the characteristic chronic diseases of the advanced ages with respect to their frequency and severity, as measured by duration. These diseases account for a large volume of disability. Thus, aging would produce both a high relative and absolute increase in the days of disability accruing from these causes. Furthermore, the increased volume of chronic disability would not be reduced to any measurable degree by the decrease in the volume of disability at the younger ages, since the diseases characteristic of this period, while frequent in occurrence, are short in duration.

THE EFFECT ON SERVICES FOR CARE OF THE SICK

The effect of an aging population on the services required in the prevention of disease and the treatment of the sick is a subject of major interest in connection with future population trends. Will an aging population produce significant changes in the amount of service given by the private physician in home and office practice, and in the volume of hospital patient days? What will be the effect of an aging population on bedside nursing care of the sick? How will an aging population alter the existing program of preventive services provided by health departments and official and nonofficial nursing agencies?

A basis for speculation concerning trends relating to services for care of the sick is again provided by the results of the canvass of white persons in thirty-one large cities included in the National Health Survey. The experience of this population with respect to medical and nursing care of disabling illness in a twelve-month period is summarized in Appendix Tables 2A-D, in which disabling illnesses of the various categories have been classified by age according to diagnosis.³⁰

³⁰ Additional data relating to the receipt of medical care as observed in the National Health Survey are included in Perrott, George St.J. and Holland, Dorothy F.: *Health as*

(Continued on page 373)

Special note should be made of the nature of the data relating to hospitalized illness shown in Appendix Table 2B. As noted previously, disabling illnesses due to tuberculosis and nervous and mental disease were incompletely enumerated in the National Health Survey. As a result, the survey records relating to medical and nursing care of these two groups of patients understate the true incidence of these patients in the various categories, as well as the frequency of services received. This deficiency is particularly marked with respect to the volume of hospital patient days for the tuberculous and mentally diseased as observed in the survey. For this reason, the experience of all patients hospitalized for the treatment of tuberculosis, nervous or mental disease has been excluded in subsequent computations. Thus, the "total number of hospital patients" and the "total number of hospital patient days" as employed in the following discussion do not represent the incidence of hospital patients and the frequency of hospital days for illness of all causes, as shown in Appendix Table 2B, but represent the experience of all patients exclusive of the tuberculous and the mentally diseased. This exclusion results in a residual group of patients which approximates those treated in general hospitals. The approximate composition of this group should be emphasized, since it is evident that patients with tuberculosis, nervous and mental disease who may have been treated in general hospitals are excluded by the procedure adopted. The records of the National Health Survey do not make possible an exact segregation of general hospital patients.

The general effect of an aging population on medical and nursing services and hospital facilities may be predicted by comparing the distribution of patients of the several categories, and the corresponding services, according to the causes of illness for which the services were received, as shown in these tables. Patients attended for illness due to the communicable diseases, tonsillitis and appendicitis, and confinement cases, occurred with high frequency in the periods of childhood, youth, or early adult life, and were relatively infrequent among older adult patients. Cancer, the degenerative

an Element in Social Security. *The Annals of the American Academy of Political and Social Science*, Philadelphia, March 1939, 202, and Britten, Rollo H.: Receipt of Medical Services in Different Urban Population Groups. *Public Health Reports*. (In Press.) See also the publication noted in footnote 10.

diseases, diseases of the digestive system (exclusive of appendicitis—in the classification used here, chiefly chronic in nature), rheumatism, and orthopedic impairments were among the major causes of illness of patients in middle and old age, and were relatively infrequent diagnoses among younger patients. In this experience, patients attended for the types of illness which were characteristically high in frequency at the younger ages, outnumbered patients treated for the chronic diseases of middle and old age in each medical and nursing category.

In respect to the volume of medical and nursing services absorbed, the relative position of these two groups of patients was reversed. The communicable diseases accounted for 14.2 per cent of all patients treated by physicians outside the hospital, but utilized only 7.8 per cent of all physicians' services. Tonsillitis (including operations on the tonsils or adenoids) accounted for 11.8 per cent of all hospital patients (exclusive of the tuberculous and all mental and nervous cases) but for only 1.6 of all hospital days of care. Hospitalized confinements terminating in live births represented 20.8 per cent of all hospital patients, but only 12.4 per cent of all hospital patient days were absorbed by this group. On the other hand, patients treated for diseases of the degenerative group represented only 9.5 per cent of all home, office, or clinic patients, but utilized 16.4 per cent of all services of this category. These diseases accounted for 7.6 per cent of all hospital patients and for 13.4 per cent of the patients attended by private duty nurses, but corresponding services for these patients represented, respectively, 13.1 and 23.0 per cent of the total. Similarly, patients treated for cancer, rheumatism, orthopedic impairments, or chronic diseases of the digestive system accounted for a disproportionately large amount of medical and nursing services. It may be expected, therefore, that aging of the population would tend to increase the number of services provided by physicians, general hospitals, and private duty nurses to a relatively greater degree than the number of patients.

Thus, more physicians, private duty nurses, and general hospital beds might be required for a given case load, as an indirect result of its changed age composition and the increased need for services for patients with the chronic diseases characteristic of middle and old age.

Estimates of the effect of the age composition of the population as estimated for 1980 on medical and nursing services for important causes of disabling illness are shown graphically in Figure 3. The age specific frequency rates of services for patients of the various categories classified by diagnosis, as shown in Appendix Tables 2A-D, have been applied to the estimated population of the United States in 1935, and to the 1980 population constructed on the basis of assumptions previously noted.

An exception to this procedure was made in estimating the number of confinements terminating in live births in the various categories, and services for these cases. The number of confinements terminating in live births attended by a physician in the hospital in 1935 was obtained from data published by the Bureau of the Census,²⁷ the number of hospital days of care for these patients being computed on the basis of the average hospital duration as observed in large cities canvassed in the National Health Survey (Appendix Table 2B). However, no published data were available concerning the total number of confinements attended by a physician (including care of patients delivered in the home, and home or office care of hospitalized patients, in the period prior to or following hospitalization), and the number of confinements receiving bedside care from a private duty or visiting nurse. Estimates relating to confinements of these categories therefore were derived from the experience of live births in the large cities canvassed in the National Health Survey (Appendix Tables, 2A, 2C, 2D), the actual number of live births occurring in the United States in 1935, increased to allow for under-registration, forming the basis for these estimates. It was assumed that the relative number of confinements receiving hospital, home, or office medical care, or bedside care from a private duty or visiting nurse, would undergo no change in 1980, but the absolute number of cases in

²⁷ United States Department of Commerce, Bureau of the Census, Vital Statistics, Special Reports, June 19, 1937, 3, No. 27, p. 135.

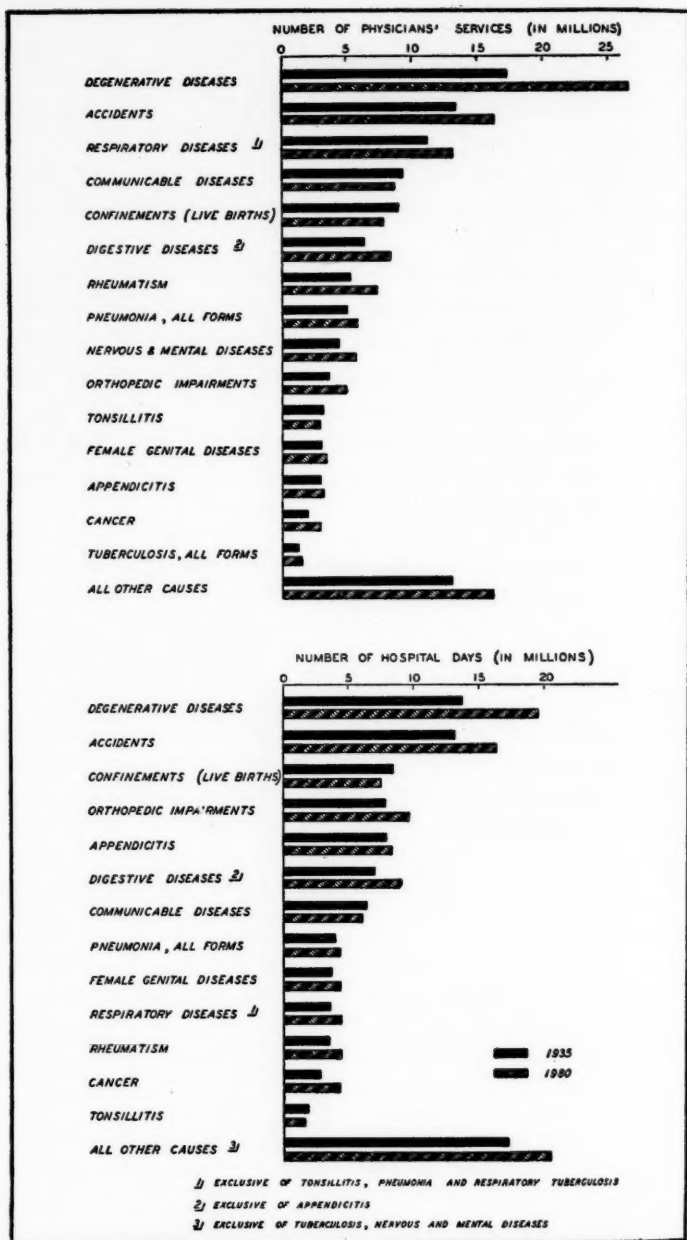


Fig. 3. Number of disabling illnesses receiving medical and nursing care in a twelve-month period and number of services in the United States in 1935 and 1980, according to cause, estimated on the basis of the experience of the National Health



Survey, 1935-1936, adjusted for age. (The method of estimating the data relating to confinements terminating in live births is described on pages 381 and 382 of the text.)

the various categories and the corresponding services were reduced in accordance with the decline in the birth rate assumed in the construction of the 1980 population.

The direction of the change between 1935 and 1980, i.e., an increase or decrease in services for patients with a given diagnosis, follows the pattern which has been observed in earlier estimates of the effect of a changed age structure on the future incidence of illness and death. Medical and nursing services for illness due to the degenerative diseases would be increased to a marked degree as a result of the aging factor alone, and services for patients with cancer, rheumatism, or the chronic diseases of the digestive system would show a generally similar trend. Taking the age specific frequency rates of services into account, by 1980, the chronic patients included in these four diagnostic groups would require services amounting to approximately 10.7 million consultations with a physician, 6.8 million hospital patient days, and 4 million days of care by a private duty nurse, in addition to the services which would be required if estimated solely on the basis of population growth. On the other hand, the increase in medical and nursing services for older patients with chronic disease would be offset, to a degree varying with the type of service, by the decrease in younger patients. Thus, in 1980, patients with acute communicable disease, tonsillitis, appendicitis, and confinement cases would require a total of approximately 27.1 million consultations with a physician, estimated solely on the basis of the increase in total population, but the number would be 4.4 million less if the age composition of the population were taken into account. Similarly, hospital days of care for patients with these diseases would be reduced in 1980 by 3.9 million days.

While the effect of population changes on institutional facilities required for care of the tuberculous and mentally diseased is incompletely measured by the experience of the National Health Survey in absolute terms, the relative nature of trends in these facilities is

more adequately represented by the survey data. Between 1935 and 1980, hospital patient days for the tuberculous would increase 10 per cent as a result of the changed age structure of the population (i.e., on the basis of estimates made by application of the age specific rates included in Appendix Table 2B), while the increase would amount to 12 per cent on the basis of total population growth. Thus, the assumed changes in age composition would tend to reduce somewhat the special hospital facilities required for care of the tuberculous. Hospital patient days for the group of patients with nervous and mental disease would show an increase of 21 per cent in this period as a result of aging of the population. However, the actual increase would be well in excess of this figure, since, in the Health Survey experience, the number of hospital patient days for the insane forms a relatively lower proportion of the total patient days of the nervous and mental group than in the general population. Dorn estimated the effect of aging of the population on the facilities of mental hospitals by applying the age-specific first commitment rates in these special hospitals in New York State (1929-1931) to the population of the United States in 1960 as estimated by Thompson and Whelpton. His results indicated that in 1960 the number of first admissions would be nearly twice as large as in 1930.³⁸

The influence of a changed age structure of the population on the total case load of physicians, nurses, and hospitals measures the composite effect of the increase in patients of middle and old age, and the associated decrease in patients drawn from the younger age groups. Estimates of this nature are shown graphically in Figure 4. They are based on age specific frequency rates of patients of the several medical and nursing categories, and of the corresponding services, derived from the results of both the National Health Survey (Appendix Table 3A), and the survey made by the Committee

³⁸ Dorn, Harold F.: The Incidence and Future Expectancy of Mental Disease. U. S. Government Printing Office, Washington, *Public Health Reports*, November 11, 1938, 53, No. 45.

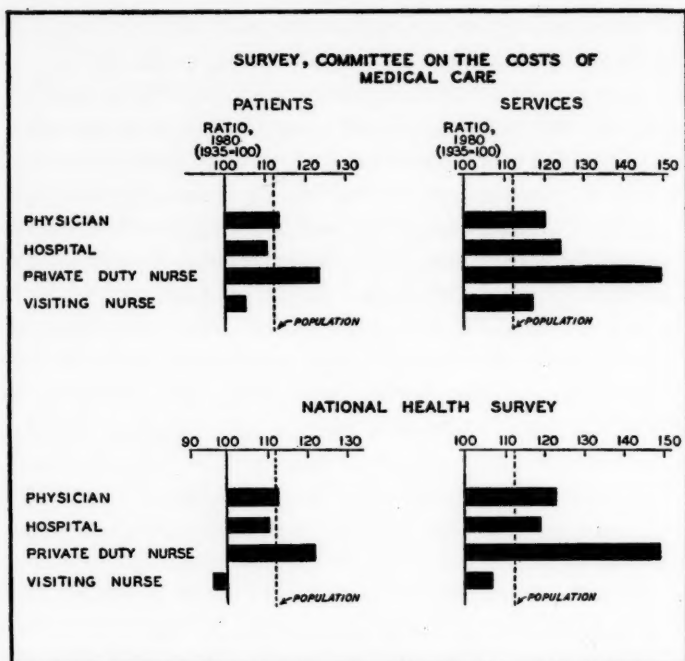


Fig. 4. Ratios of patients receiving medical and nursing care in a twelve-month period, and of the corresponding services, in the United States in 1980, to patients and services in 1935, estimated on the basis of the experience of the survey of the Committee on the Costs of Medical Care, 1928-1931, and the National Health Survey, 1935-1936, adjusted for age. Hospital patients (and services) are exclusive of the experience of hospitalized cases of tuberculosis, nervous and mental disease. The definitions of the several categories of patients are included in Appendix Tables 3A and B.

on the Costs of Medical Care in 1928-1931 (Appendix Table 3B). A comparison of this kind seemed of interest as an indication of the effect of population changes on the medical services for all types of illness (i.e., both disabling and nondisabling), recorded in the survey of the Committee on the Costs of Medical Care, as distinguished from the records of the National Health Survey which relate only to services for illness disabling for a minimum of seven consecutive days in a twelve-month period. Estimates based on the

Committee's data have additional value since the surveyed families were drawn from large and small cities and rural areas, while the results of the National Health Survey selected for these estimates relate only to surveyed families in cities of 100,000 population and over. The rates employed in estimates based on the results of the Committee's survey were obtained from an analysis of the Committee's data made by Collins, adjusted for the purposes of the present report.³⁹ In the estimates of the trend in hospital patients and hospital patient days the experience of all hospitalized illnesses in which tuberculosis, nervous or mental disease was the sole or primary cause of the illness has been excluded from the data of both surveys.

It has been assumed that the age specific frequency rates of patients receiving the various types of medical and nursing care, and of services received, as observed in these surveys, would prevail in 1980 for all patients except confinement cases, for which the following procedure was adopted. The total number of confinements terminating in live births in the United States in 1935 was estimated by increasing the actual number of live births reported in this year to allow for under-registration. For all categories except hospitalized patients, the distribution of confinements according to type of attendant at delivery, and the number of physicians' and nurses' services received in 1935 were estimated on the basis of (1) the experience of large cities included in the National Health Survey and (2) the survey of the Committee on the Costs of Medical Care. The number of confinements terminating in live births attended by a physician in the hospital was obtained from data published by the Bureau of the Census,⁴⁰ the number of hospital days of care for these patients being computed on the basis of the average

³⁹ The frequency rates of illness attended by a medical practitioner according to age, based on the results of the survey of the Committee on the Costs of Medical Care, were estimated from rates included in a report of the results of the Committee's survey as analyzed by Collins (Collins, Selwyn D.: Frequency and Volume of Doctors' Calls Among Males and Females in 9,000 Families, Based on Nation-wide Periodic Canvasses, 1928-31. To be published in: *Public Health Reports*, November 1, 1940, 55, No. 44).

The rates used in estimates relating to the receipt of hospital and nursing care are based on unpublished data from the survey of the Committee on the Costs of Medical Care made available from current studies of Dr. Selwyn D. Collins. See also footnote 8 for a general summary of the results of the survey of the Committee on the Costs of Medical Care.

hospital duration as observed in the survey of the Committee on the Costs of Medical Care. Thus, in the estimates based on the results of these surveys, the number of hospitalized confinements and hospital days of care for these patients is uniform, but the number of confinements of other categories and the corresponding services varies according to the experience of the survey under consideration. It was assumed that the number of confinements in the various categories, and the services received would form the same proportion of the respective totals in 1980 as in 1935, but the absolute number of the attended confinements and services for these patients in 1980 was reduced in accordance with the decline in the birth rate assumed in the construction of the 1980 population. The estimates made by the methods outlined were used as the basis for frequency rates of confinement cases and services therefor, in the estimated population of the United States in 1935 and 1980. These rates, taken as the equivalent of age-adjusted rates, when combined with the age-adjusted rates for patients and services of the several categories, exclusive of confinements, formed age-adjusted rates for all patients of each category.

As the results plotted in Figure 4 indicate, no material increase in the total case load of physicians in home or office practice, or of general hospitals would occur as the result of the assumed changes in age composition of the population between 1935 and 1980. The increment of patients in middle and old age would be balanced by the decline in younger patients. Hospital patients, exclusive of the tuberculous and mentally diseased, if estimated on the basis of age specific incidence rates, would be somewhat less numerous in 1980 than would be predicted with reference to the rate of population growth. However, as a result of aging of the population, the increase in the number of physicians' services would amount to 8 to 11 per cent more than the percentage increase in the population (8 per cent, data of the Committee on the Costs of Medical Care, 11 per cent, data of the National Health Survey) between 1935 and 1980. In this period, the factor of aging alone would account for an increase in hospital days of care (exclusive of patient days for the tuberculous and mentally diseased) amounting to 7 per cent, as

estimated on the basis of results of the National Health Survey, and 12 per cent, on the basis of the experience of the Committee on the Costs of Medical Care. Thus, the increase in the volume of physicians' services and hospital days of care resulting from the increment of older patients indirectly would alter the case load of physicians and hospitals, and additional medical personnel and hospital facilities might be required to maintain medical care at its present standards.

Among the various services for care of the sick, aging of the population would effect the greatest change in the field of private duty nursing. The factor of aging alone would produce a marked increase both in the number of patients of private duty nurses and the number of nursing days of care. On the other hand, patients receiving the services of visiting nurses would increase at a rate lower than the total population under the assumed changes in age composition. On the basis of the results of the National Health Survey, the volume of visiting nurse service would also increase at a rate lower than the rate of population growth if changes in age structure were taken into account. However, estimates based on the records of the Committee on the Costs of Medical Care show an opposite trend, the volume of the services of visiting nurses increasing as a result of changes in age composition between 1935 and 1980 at a relatively higher rate than that of the total population.

THE EFFECT ON ORGANIZED HEALTH SERVICES

The activities which form an established part of the program of health departments and nonofficial health agencies are directed in relatively small degree to health supervision of persons of middle and old age. This limitation is a natural consequence of the traditional restriction of public health services to those involved in the control of preventable disease. Thus, the changing age structure of the population may be expected to produce effects opposite in nature on public health and medical services. The incre-

ment of older persons would tend to increase the total volume of home and office medical services as well as the days of hospital care. On the other hand, a decline in the number of children, youth, and young adults would result in a reduction of the volume of preventive services which now receive the major emphasis of organized health agencies. Activities for the control of tuberculosis would share in this decline. The program for the control of venereal disease would be less affected since the decline in services for young adults would be balanced to some extent by an increase in services for those in middle age. Aging of the population will give impetus to the further development of activities in the control of pneumonia and cancer. Health supervision of the worker, and in particular, the worker of middle age, will receive increasing recognition as a strategic method of averting certain health problems of the aged.

GENERAL IMPLICATIONS

Solution of the health problems associated with aging of the population will require the intensive application of existing methods for the prevention of disease to a larger number of the population than is now receiving the benefits of preventive medicine. Health gains in infancy and childhood have been chiefly responsible for the increase in average life expectancy, yet this field offers opportunity for further substantial improvement. Deaths of infants from congenital malformations and debility, birth injuries, and the broad group of the diseases of early infancy average about 63,000 annually, these conditions taken together ranking among the leading causes of death in the total population of all ages. Adequate prenatal and infant care is of demonstrated value in reducing both puerperal and neonatal mortality. School children and workers in industry afford opportunity for effective group health supervision. The specific attack on tuberculosis and the venereal diseases provides an additional approach to the health problems of young adults.

Yet at certain points, the provision of preventive health services alone leaves the greater part of the health problem unsolved. The maternity case requires competent attendance at delivery as well as supervision in the prenatal period. Control of the communicable diseases of childhood requires not only preventive measures, but treatment of the sick child. Tuberculosis and syphilis control involves both case-finding and adequate treatment of cases and their contacts when found. The characteristic chronic diseases of middle and old age are subject to control primarily through therapeutic measures. On the whole, organized health agencies assume relatively little responsibility for making these curative services available. Individual, rather than community, income is the chief determining factor in the receipt of medical care, and individual income is generally recognized to be inadequate for medical needs in a large proportion of the population, particularly among the aged.

A possible solution of this impasse lies in the employment of public funds to provide both preventive and curative services for those groups of the population unable to support the costs of such care from individual income. The promotion of such a plan through the system of Federal grants-in-aid would be achieved by a national health program such as has been proposed by the President's Interdepartmental Committee to Coordinate Health and Welfare Activities. The need for a comprehensive health program of wide scope is daily brought to the attention of the administrators of the various titles of the Social Security Act. Under the public assistance titles, there is no adequate means of providing Federal grants for medical care. The appropriations made available under Title VI (Public Health Work) have been insufficient to support more than the first steps in the development of public health services adapted to the needs of those in middle and old age. Disability insurance is a pressing need which will increase in importance as the population ages. Small grants are made under the Act for vocational rehabilitation but they by no means meet the needs in this field.

Finally, an important approach to the solution of this broad problem is offered through the extension of research in the cause and control of the chronic diseases characteristic of advanced life. Effective control of certain of these diseases, of which cancer is an outstanding example, is in part dependent on the demonstration of the etiologic agents involved. Opportunity should be provided for the appraisal of existing methods of diagnosis and treatment, and the exploration of new procedures designed to bring the chronic diseases under early control. But an equally fruitful field of research consists in the development of public health methods which will solve the unique problems involved in coordinating the control of the chronic diseases in the community health program.

Appendix Table 1. Frequency and disability rates of illness disabling¹ for seven consecutive days or longer in a twelve-month period classified by diagnosis according to age, in 1,581,577 white persons² in thirty-one cities of 100,000 population and over canvassed in the National Health Survey, 1935-1936.

DIAGNOSIS ³	ALL AGES	UNDER 15 YEARS	15-24	25-64	65 AND OVER	ALL AGES	UNDER 15 YEARS	15-24	25-64	65 AND OVER
ALL CAUSES	DISABLING ILLNESSES PER 1,000 PERSONS					DAYS OF DISABILITY PER 1,000 PERSONS				
	160.3	211.7	116.1	141.5	261.6	9,508	5,842	5,053	10,023	34,078
Communicable Diseases	25.5	93.4	8.0	3.6	2.0	634	2,146	208	157	134
Tonsillitis	10.0	25.7	8.2	4.6	.83	137	327	112	73	26
Pneumonia, All Forms	4.3	7.5	2.1	3.2	8.4	171	276	79	136	343
Other Diseases of the Respiratory System	32.8	40.7	24.0	31.1	43.9	780	642	437	838	1,901
Appendicitis	5.0	3.8	10.0	4.2	.88	196	125	365	186	59
Other Diseases of the Digestive System	7.0	3.2	2.9	9.0	17.0	518	94	144	707	1,700
The Puerperal State: Live Births	13.4	.021	25.1	16.9	—	311	.4	571	395	—
Other Puerperal Conditions and Female Genital Diseases	3.5	.10	3.6	5.3	.75	227	8	165	360	81
Cancer	1.0	.019	.036	1.2	6.2	143	2	6	170	919
Rheumatism	5.3	1.2	1.4	6.8	21.3	665	81	111	761	3,948
Degenerative Diseases	12.8	3.5	3.1	13.4	77.8	1,573	242	310	1,600	10,875
Tuberculosis, All Forms	1.3	.48	1.5	1.6	.87	318	91	345	422	200
Nervous and Mental Disease	5.4	2.6	4.0	6.6	9.3	1,034	444	832	1,272	1,913
Orthopedic Impairments	2.9	1.2	1.5	2.9	14.5	879	286	379	872	5,012
Accidents	15.0	10.8	12.4	16.5	27.0	735	354	494	855	1,969
All Other Causes	15.1	17.3	8.3	14.6	31.0	1,186	723	495	1,218	4,999

See footnotes following Appendix Table 2 D.

Appendix Table 2A. Frequency rates of disabling¹ illness receiving care from a physician in the patient's home, the physician's office, or in a clinic, and of physicians' services, classified by diagnosis according to age, in 1,581,577 white persons² in thirty-one cities of 100,000 population and over canvassed in the National Health Survey, 1935-1936.

DIAGNOSIS ³	ALL AGES	UNDER 15 YEARS	15-24	25-64	65 AND OVER	ALL AGES	UNDER 15 YEARS	15-24	25-64	65 AND OVER
ALL CAUSES	PHYSICIANS' CASES PER 1,000 PERSONS					PHYSICIANS' SERVICES PER 1,000 PERSONS				
	113.9	144.2	79.6	103.2	195.9	850.3	623.9	508.4	927.4	2,149.3
Communicable Diseases	16.2	58.4	5.0	2.7	1.6	66.1	203.6	27.1	23.1	16.6
Tonsillitis	7.8	20.0	6.2	3.7	.58	23.0	50.3	19.3	14.2	2.9
Pneumonia, All Forms	3.8	6.6	1.8	2.8	7.5	38.2	59.1	17.1	31.4	80.3
Other Diseases of the Respiratory System	19.5	24.4	13.2	18.6	26.7	87.9	82.8	56.5	93.9	152.6
Appendicitis	4.4	3.4	8.6	3.8	.72	23.0	14.3	40.8	23.0	4.0
Other Diseases of the Digestive System	5.8	2.5	2.3	7.5	14.0	52.5	10.9	17.4	74.1	134.3
The Puerperal State: Live Births	8.6	.013	15.8	10.8	—	49.3	.088	91.6	62.4	—
Other Puerperal Conditions and Female Genital Diseases	2.9	.088	3.0	4.4	.63	24.6	.91	23.7	37.6	4.7
Cancer	.83	.011	.029	.99	5.4	15.2	.16	.54	19.2	87.3
Rheumatism	3.8	1.0	1.2	4.9	14.0	43.2	10.2	12.1	56.8	151.7
Degenerative Diseases	10.9	2.8	2.5	11.3	66.8	139.7	25.0	24.7	151.6	871.0
Tuberculosis, All Forms	.84	.28	.91	1.1	.64	10.5	2.8	10.7	13.9	10.7
Nervous and Mental Disease	3.3	1.7	2.1	4.1	6.2	36.2	12.2	21.6	47.9	73.0
Orthopedic Impairments	1.7	.76	.73	1.7	7.9	29.4	10.9	11.4	34.6	114.4
Accidents	11.9	8.8	9.7	13.1	20.8	108.3	56.8	81.9	131.3	189.8
All Other Causes	11.8	13.4	6.4	11.7	22.4	103.0	83.8	52.1	112.4	256.1

See footnotes following Appendix Table 2 D.

Appendix Table 2B. Frequency rates of hospitalized illness⁴ and of hospital patient days, classified by diagnosis according to age, in 1,581,577 white persons⁵ in thirty-one cities of 100,000 population and over canvassed in the National Health Survey, 1935-1936.

DIAGNOSIS ³	ALL AGES	UNDER 15 YEARS	15-24	25-64	65 AND OVER	ALL AGES	UNDER 15 YEARS	15-24	25-64	65 AND OVER
	HOSPITAL CASES PER 1,000 PERSONS					HOSPITAL DAYS PER 1,000 PERSONS				
ALL CAUSES	49.3	41.6	51.9	51.4	52.2	1,260.7	739.6	1,109.9	1,472.0	1,930.0
Communicable Diseases	1.8	4.7	1.3	.71	.56	46.0	125.8	30.7	18.4	18.2
Tonsillitis	5.5	15.4	4.3	2.1	.25	13.3	33.0	10.3	6.7	1.4
Pneumonia, All Forms	1.5	2.7	.72	1.1	2.3	30.1	55.8	14.8	22.9	38.1
Other Diseases of the Respiratory System	1.5	1.2	1.7	1.5	1.7	29.3	24.1	23.9	33.0	33.1
Appendicitis	4.5	3.4	8.9	3.8	.64	61.9	45.6	113.6	57.0	13.9
Other Diseases of the Digestive System	2.5	.74	1.0	3.6	4.1	58.2	14.6	21.2	85.1	104.4
The Puerperal State: Live Births	9.7	.013	18.6	12.1	—	104.4	.12	195.7	131.4	—
Other Puerperal Conditions and Female Genital Diseases	2.1	.037	1.9	3.3	.49	31.4	.65	23.8	50.1	7.8
Cancer	.64	.013	.025	.85	3.2	23.8	.65	1.4	31.1	122.0
Rheumatism	.70	.32	.36	.90	1.5	29.7	17.0	14.0	37.1	62.5
Degenerative Diseases	3.6	1.5	1.2	4.0	15.6	110.5	45.0	34.7	122.8	513.9
Tuberculosis, All Forms	.80	.36	1.1	.95	.36	139.4	63.0	209.9	161.2	32.0
Nervous and Mental Disease	1.8	.99	1.4	2.2	2.0	280.3	78.0	205.5	392.9	303.4
Orthopedic Impairments	.74	.66	.65	.70	1.7	61.6	51.8	57.6	55.1	177.5
Accidents	5.6	4.2	5.2	5.9	9.3	104.9	61.9	80.1	116.3	256.0
All Other Causes	6.4	5.4	3.5	7.6	8.6	136.1	122.5	74.7	151.0	245.8

See footnotes following Appendix Table 2 D.

Appendix Table 2C. Frequency rates of disabling¹ illness receiving care from a private duty nurse,² and of nursing days, classified by diagnosis according to age, in 1,581,577 white persons⁵ in thirty-one cities of 100,000 population and over canvassed in the National Health Survey, 1935-1936.

DIAGNOSIS ³	ALL AGES	UNDER 15 YEARS	15-24	25-64	65 AND OVER	ALL AGES	UNDER 15 YEARS	15-24	25-64	65 AND OVER
	PRIVATE DUTY NURSES' CASES PER 1,000 PERSONS					NURSING DAYS PER 1,000 PERSONS				
ALL CAUSES	5.46	2.60	3.40	6.15	17.43	156.49	48.61	45.03	147.33	1,046.92
Communicable Diseases	.31	.80	.14	.15	.15	6.48	15.64	3.13	3.61	5.70
Tonsillitis	.12	.27	.067	.069	.056	.42	.87	.28	.27	.28
Pneumonia, All Forms	.50	.47	.25	.46	1.78	8.80	8.61	3.19	8.36	31.32
Other Diseases of the Respiratory System	.35	.28	.16	.39	.92	6.03	5.73	2.55	6.28	15.90
Appendicitis	.44	.25	.59	.51	.079	4.89	3.08	5.44	5.83	1.87
Other Diseases of the Digestive System	.31	.034	.078	.43	1.10	7.69	.78	1.30	10.55	29.81
The Puerperal State: Live Births	1.05	.003	1.54	1.47	—	12.48	.075	15.62	18.28	—
Other Puerperal Conditions and Female Genital Diseases	.21	.003	.11	.34	.10	3.22	.008	1.83	5.32	1.32
Cancer	.14	.003	—	.17	.88	6.39	.11	—	8.96	28.62
Rheumatism	.10	.013	.011	.12	.55	6.60	1.22	.17	7.90	37.25
Degenerative Diseases	.73	.061	.050	.60	6.87	35.92	1.11	.91	24.75	397.85
Tuberculosis, All Forms	.020	.005	.015	.023	.078	1.90	.10	.19	1.68	16.95
Nervous and Mental Disease	.13	.032	.053	.16	.54	9.42	.86	2.40	9.43	67.41
Orthopedic Impairments	.10	.023	.035	.081	.83	15.47	.81	1.09	9.04	183.05
Accidents	.36	.091	.17	.42	1.56	12.64	5.07	4.15	12.40	73.38
All Other Causes	.59	.25	.13	.75	1.93	18.13	4.54	2.78	14.66	156.24

See footnotes following Appendix Table 2 D.

Appendix Table 2D. Frequency rates of disabling¹ illness receiving bedside care from a visiting nurse, and of nursing visits, classified by diagnosis according to age, in 1,581,577 white persons² in thirty-one cities of 100,000 population and over canvassed in the National Health Survey, 1935-1936.

DIAGNOSIS ³	ALL AGES	UNDER 15 YEARS	15-24	25-64	65 AND OVER	ALL AGES	UNDER 15 YEARS	15-24	25-64	65 AND OVER
	VISITING NURSES' CASES PER 1,000 PERSONS					NURSING VISITS PER 1,000 PERSONS				
ALL CAUSES	12.31	29.53	8.10	6.53	7.79	64.34	93.71	46.73	52.45	108.96
Communicable Diseases	5.40	21.41	.98	.31	.079	14.94	57.43	3.34	1.46	.19
Tonsillitis	.48	1.65	.26	.085	.011	1.31	4.06	.77	.40	.10
Pneumonia, All Forms	.41	.97	.15	.24	.46	3.71	7.59	1.92	2.48	4.62
Other Diseases of the Respiratory System	.96	2.39	.47	.53	.52	3.76	7.91	2.14	2.57	2.68
Appendicitis	.15	.16	.26	.12	.011	1.09	.75	1.85	1.08	.079
Other Diseases of the Digestive System	.21	.22	.086	.23	.47	2.08	1.08	.61	2.63	5.75
The Puerperal State: Live Births	2.29	—	4.52	2.81	—	13.57	—	25.25	17.16	—
Other Puerperal Conditions and Female Genital Diseases	.22	.011	.22	.33	.045	1.81	.024	1.60	2.82	.40
Cancer	.08	—	.007	.10	.48	1.69	—	.11	2.20	8.95
Rheumatism	.15	.11	.061	.17	.49	2.10	.98	.67	2.45	7.90
Degenerative Diseases	.45	.28	.14	.41	2.63	5.33	2.06	2.10	4.96	32.75
Tuberculosis, All Forms	.25	.064	.34	.31	.18	1.75	.50	2.04	2.26	1.27
Nervous and Mental Disease	.13	.18	.10	.12	.12	1.02	.96	.57	1.18	1.25
Orthopedic Impairments	.12	.13	.057	.083	.58	2.40	1.40	.78	1.88	16.55
Accidents	.34	.40	.23	.30	.83	3.08	1.67	1.16	3.16	14.31
All Other Causes	.67	1.56	.22	.39	.87	4.70	7.21	1.81	3.76	12.14

¹ Disabling for seven consecutive days or longer in a twelve-month period. All confinements, fatal, and hospital cases are included without reference to the duration of disability.

² Exclusive of persons of unknown age or unknown income.

³ The classification by diagnosis is made on the basis of the sole or primary cause of the illness. The diseases included in the broad diagnosis groups are as follows:

Communicable Diseases: chiefly the communicable diseases of childhood: measles, mumps, chickenpox, whooping cough, scarlet fever, and diphtheria.

Other Diseases of the Respiratory System: influenza, colds, bronchitis, pleurisy, sinusitis, asthma, hay fever, and other diseases of the respiratory system except tonsillitis, pneumonia, and respiratory tuberculosis.

Other Diseases of the Digestive System: indigestion, biliousness, diarrhea and enteritis, ulcer of the stomach or duodenum, diseases of the gall bladder or liver, and other diseases of the digestive system except appendicitis.

Other Puerperal Conditions and Female Genital Diseases: abortions, miscarriages, and stillbirths; complications of pregnancy; cysts of the ovaries, uterus, and tubes; displacement and lacerations of the female genital organs; pelvic inflammatory disease; and other nonpuerperal diseases of the female genital organs except cancer and nonmalignant tumors.

Degenerative Diseases: diabetes; cerebral hemorrhage and other forms of paralysis; diseases of the heart, arteriosclerosis and high blood pressure, and other diseases of the circulatory system, exclusive of hemorrhoids and varicose veins; nephritis and other nonvenereal diseases of the genitourinary system, exclusive of diseases of the female genital organs.

Nervous and Mental Disease: general paralysis of the insane and other forms of insanity; neurasthenia, locomotor ataxia, epilepsy, chorea and other diseases of the nervous system; and mental defects.

⁴ In enumerating hospitalized illnesses, no limitation was imposed concerning the duration of the disability. Hospitalized illnesses include: (1) cases in which the hospitalized illness or injury was the sole cause of disability; (2) cases in which multiple causes were assigned to the illness, and hospital care was received for the primary, or any contributory, cause of the illness.

⁵ Includes care in the home and special nursing care in the hospital.

Appendix Table 3A. Estimated frequency rates of disabling¹ illness receiving medical and nursing care, and of medical and nursing services, according to age, in a surveyed population, and estimated number of cases and services in the United States in 1935 and 1980. (Based on the experience of 1,581,577 white persons² in thirty-one cities of 100,000 population and over canvassed in the National Health Survey, 1935-1936.³)

MEDICAL CATEGORY	ALL AGES (CRUDE)	AGE ⁴				ESTIMATED NO. OF CASES, SERVICES IN THE UNITED STATES (IN 1,000'S), BASED ON AGE-ADJUSTED RATES ⁵	
		Under 15 Years	15-24	25-64	65 and Over		
		CASES AND SERVICES PER 1,000 PERSONS				1935	1980
Physician: ⁶							
Cases	117.6	144.2	85.6	109.3	195.9	15,230	17,176
Services	871.4	623.9	543.6	962.4	2,149.3	109,946	135,238
Hospital: ⁷							
Cases	43.2	40.3	42.4	44.6	49.9	5,514	6,102
Services	822.2	598.5	636.2	890.6	1,594.5	102,612	121,977
Private Duty Nurse: ⁸							
Cases	5.9	2.6	4.0	7.0	17.4	751	915
Services	161.8	48.6	51.0	157.6	1,046.9	20,476	30,480
Visiting Nurse: ⁷							
Cases	13.3	29.5	9.8	8.1	7.8	1,808	1,743
Services	70.1	93.7	56.4	62.1	109.0	9,220	9,846

¹ See footnotes 1 and 4, Appendix Table 2D.

² See footnote 2, Appendix Table 2D.

³ The age specific rates shown here for all causes of illness are estimated rates, representing the combination of estimated rates relating to confinements terminating in live births, and observed rates, as shown in Appendix Tables 2A-D, for all other causes of illness. The proportion of confinements (live births only) in all categories except hospital patients, and the corresponding services received were estimated from the rates shown in Appendix Tables 1A, 2A, 2C, and 2D, but the actual number of live births occurring in the United States in 1935, increased to allow for under-registration (i.e., 2,434,000 live births) was taken as the base for these estimates. The number of hospitalized confinements in 1935 was obtained from data published by the Bureau of the Census (see reference 17), the number of hospital days being estimated on the basis of the average duration as observed in the survey of the Committee on the Costs of Medical Care. The estimated number of confinements in the various categories, and the corresponding services, derived as stated, were distributed by age in the proportions indicated by the rates shown in Appendix Tables 2A-D. The number of confinements terminating in live births in 1980, estimated at 2,132,000, in accordance with assumptions made in the construction of the 1980 population, was taken as the base for the estimates in 1980.

⁴ Includes care by a medical practitioner in the patient's home, the physician's office, or in a clinic. Records of medical consultations for the purpose of instruction in prenatal hygiene were incomplete and were, therefore, excluded in coding the survey data.

⁵ The frequency rates of hospitalized cases of tuberculosis and nervous and mental disease, and of hospital services for these patients, shown in Appendix Table 2B, have been excluded in all computations relating to hospital patients and days of care.

⁶ See footnote 5, Appendix Table 2D.

⁷ Includes bedside care only.

⁸ Data by age in detailed periods are not available.

⁹ Adjusted to the estimated age distribution of the United States in 1935 and 1980. The estimates for 1980 are based on adjusted rates which take into account the decline in births assumed in the construction of the 1980 population. They represent a reduction of the adjusted rates expected on the basis of the age specific rates included in this table, in the following proportions (percentage reduction of the latter rate in the category specified): physicians' cases, 2.2, services, 1.6; hospital cases, 3.0, services, 1.9; private duty nurses' cases, 5.6, services, 2.0; visiting nurses' cases, 3.3, services, 5.8.

MEDICAL CATEGORY	ALL AGES ² (Crude)	AGE										ESTIMATED NO. OF CASES, SERVICES IN THE UNITED STATES (IN 1,000's), BASED ON AGE-ADJUSTED RATES ¹¹	
		Under 5 Years	5-9	10-14	15-19	20-24	25-34	35-44	45-54	55-64	65 and Over		
		CASES AND SERVICES PER 1,000 PERSONS ALL CAUSES (ESTIMATED) ¹⁰											
Physician: ³												1935	1980
Cases	64.0	94.9	69.8	47.2	42.7	51.7	65.4	59.9	56.6	60.1	72.7	78,137	88,468
Services	2,537	2,561	2,119	1,620	1,668	2,478	3,060	2,812	2,752	2,983	4,957	336,881	403,143
Hospital: ⁴													
Cases	56.6	48.6	61.2	42.9	41.0	65.0	79.3	59.2	43.0	40.1	66.1	7,144	7,874
Services	665.3	549.2	406.3	558.7	330.4	745.1	848.7	763.1	664.8	851.3	1,901.8	92,501	114,747
Private Duty Nurse: ⁵													
Cases	23.4	13.8	14.0	11.4	13.1	27.7	37.9	29.0	20.6	31.2	69.1	3,311	4,087
Services	409.9	219.7	167.8	85.2	139.3	372.4	503.2	484.4	450.0	913.8	3,154.3	68,812	102,501
Visiting Nurse: ⁶													
Cases	31.1	43.5	30.1	21.4	15.7	34.4	45.1	28.9	15.5	17.0	28.1	3,667	3,844
Services	209.3	191.9	116.7	124.3	92.2	231.6	363.1	244.5	140.3	167.7	510.0	27,760	32,366
(EXCLUSIVE OF CONFINEMENTS TERMINATING IN LIVE BIRTHS) ⁹													
Physician: ⁷													
Cases	61.2	94.9	69.8	47.2	42.0	47.5	58.9	57.3	56.5	60.1	72.7		
Services	2,378	2,561	2,119	1,620	1,606	2,117	2,472	2,613	2,743	2,983	4,957		
Hospital: ⁷													
Cases	50.4	48.6	61.2	42.9	39.0	51.4	56.0	51.1	41.7	40.1	66.1		
Services	589.7	549.2	406.3	558.7	308.5	569.1	574.8	663.1	660.7	851.3	1,901.8		
Private Duty Nurse: ⁷													
Cases	18.2	13.8	14.0	11.4	11.5	18.4	28.4	21.1	20.6	31.2	69.1		
Services	333.8	219.7	167.8	85.2	119.7	236.9	332.6	345.9	450.0	913.8	3,154.3		
Visiting Nurse: ⁷													
Cases	22.2	43.5	30.1	21.4	12.1	13.7	15.1	15.5	14.6	17.0	28.1		
Services	140.7	191.9	116.7	124.3	64.3	83.5	132.8	137.4	128.6	167.7	510.0		

Appendix Table 3B. Estimated frequency rates of illness¹ receiving medical and nursing care, and of medical and nursing services, according to age, in a surveyed population, and estimated number of cases and services in the United States in 1935 and 1980. (Based on the experience of 39,185 white persons² in 130 urban and rural areas canvassed in the survey of the Committee on the Costs of Medical Care, 1928-1931.)

¹ Includes nondisabling illness, and illness disabling for one day or longer.

² Equivalent to 38,544 person years of life.

³ Includes care by any medical practitioner, in the patient's home, the physician's office, or in a clinic, and care by a private physician in the hospital. Medical consultations for the purpose of instruction in prenatal hygiene are included.

⁴ Exclusive of the experience of hospitalized cases of tuberculosis and nervous and mental disease.

⁵ Includes care in the home and special nursing care in the hospital.

⁶ Includes both bedside care and instructive service.

⁷ Footnotes 3-6 above apply here except as they relate to live births which are excluded from these rates by definition.

⁸ Includes a small number of unknown age.

⁹ The source of the age specific rates shown for "all causes, exclusive of confinements terminating in live births" is as follows:

Illnesses attended by a *private duty nurse* and *visiting nurse*: unpublished rates as observed in the survey of the Committee on the Costs of Medical Care. *Hospitalized* illnesses:

(Continued on page 392)

unpublished rates as observed in the survey of the Committee on the Costs of Medical Care, exclusive of the experience of hospitalized cases of tuberculosis and nervous and mental disease. Illnesses attended by any *medical practitioner*: the frequency rates of illnesses of this category were estimated on the basis of rates observed in the survey of the Committee on the Costs of Medical Care (see reference 10). The rates available in this forthcoming publication include the age incidence of the total illnesses attended by (1) any practitioner, i.e., medical or nonmedical, and (2) nonmedical practitioners, with or without a medical attendant. These classes were not mutually exclusive with respect to attended illnesses, and it was necessary therefore to estimate the incidence of illness attended by medical practitioners. A special tabulation of the total illnesses, all ages, attended by nonmedical practitioners, with or without care from a medical practitioner, indicated that 76 per cent were attended by nonmedical practitioners only. By assuming that this proportion would obtain in each age group, the age incidence of illness attended by nonmedical practitioners only was estimated. These estimated rates were subtracted from the age specific incidence rates of illness attended by any practitioner (medical or nonmedical), thus deriving estimated frequency rates of illness attended by a medical practitioner. From the tabulations available, exact rates of this nature could not be computed. However, the frequency rates of services of the several categories as reported in this study relate to mutually exclusive groups. For the purposes of the present report, the age specific frequency rates of services received from medical practitioners were obtained by subtracting the rates relating to nonmedical practitioners from the rates relating to "any practitioner."

¹⁰ The age-specific rates shown for "all causes, estimated," represent the combination of the age-specific rates for "all causes, exclusive of confinements terminating in live births" (see footnote 9) with estimated age-specific rates relating to confinements terminating in live births. The general procedure employed in making these estimates is described in the third footnote in Appendix Table 3A, but the experience of live births observed in the survey of the Committee on the Costs of Medical Care formed the basis for the estimates of the number of confinements attended by any medical practitioner, or by a private duty nurse or visiting nurse, used in Appendix Table 3B. The number of hospitalized confinements in 1935 was obtained from data published by the Bureau of the Census (see reference 17), the number of hospital days for these patients being estimated on the basis of the average duration as observed in the survey of the Committee on the Costs of Medical Care (12.1 days per hospitalized confinement terminating in a live birth). The age distribution of confinements of the various categories and the corresponding services was also based on the experience of the Committee's survey.

¹¹ Adjusted to the estimated age distribution of the United States in 1935 and 1980. The estimates for 1980 are based on adjusted rates which take into account the decline in births assumed in the construction of the 1980 population. They represent a reduction of the adjusted rates expected on the basis of the age-specific rates included in this table, in the following proportions (percentage reduction of the latter rate in the category specified): physicians' cases, .40, services, .74; hospital cases, 1.5, services, 1.2; private duty nurses' cases, 2.4, services, 1.5; visiting nurses' cases, 4.3, services, 4.0.

ADAPTING PROGRAMS OF SOCIAL WELFARE TO A CHANGING POPULATION

PHILIP KLEIN¹

I SHOULD like to preface these remarks by saying that social scientists are still too lacking in conviction about the importance of so-called theoretical considerations. Abstract academic findings often have far greater practical importance than immediate palpable facts. This question of adapting programs of social welfare to a changing population is a good example of the sterility of separating theoretical analysis from practical measures. I think that the most important measures for meeting social welfare problems have their rational roots in the problems of population. It is not even a question of "adapting programs" but rather of constructing and creating them out of the significant happenings in population change.

A further premise upon which these remarks are based is that the most important area of social welfare is that which lies in the realm of economics. This is not to deny that there are other problems of social welfare, but to say that they are either corollary or of lesser significance or less pressing.

The reason why prosperity is not "just around the corner," why it *can not* be just around the corner lies chiefly in the population changes and in the field of technology, the two reacting upon each other, and creating the economic conditions of the present.

The principal socio-economic problems of which the general public is conscious and about which a great deal is heard from one or another combination of interests and articulate groups are:

1. That there is too much unemployment in industry, and that the income of the agricultural population is too low.

¹ From the New York School of Social Work.

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2. That opportunities for investment are restricted and thus the expansion of economic activity (sometimes called prosperity) prevented. Generally speaking, the Government is held responsible for this stagnancy.

3. That welfare services are getting too expensive: the nation cannot afford them; therefore resistance is offered to social security, relief, national health programs, improved school systems, etc., etc.

A system of social welfare measures cannot be both effective and permanent unless it takes full account of the difficulties implied in these three major economic complaints. I do not pretend in what follows to present new facts or even new relationships, but merely to emphasize that a social welfare system for this country must relate itself both to these economic complaints and to the underlying population facts that largely determine the underlying conditions of our economy.

I would put it as an axiom that growing economic activity depends upon growing consumer power. The consumer power can be either national or foreign; it can be either quantitative, that is, larger amounts of the same things, or qualitative, that is, an increase in standards of consumption. The practically continuous increase in basic prosperity of the United States may be reasonably understood in the light of its history of consistently increasing population, that is, consumer power together with the known rise in standards of living. It would be a natural inference, therefore, that if population increase is retarded and increase in consumer power diminishes, prosperity is also likely to be slowed up. This major change in population trend has actually taken place, and the check in expanding consumer power has arrived. It has been more pronounced in fact than it might have been because of the abnormal increase in production associated with the World War. This slowing down in the growth of national consuming power might not have had the pronounced retarding effect on prosperity if foreign markets had proportionately increased. That, however, has not

happened and expansion of production with its associated increase in investment opportunities has not occurred. It is, therefore, reasonable that something more than a temporary decrease in prosperity should set in.

And here is where the second major factor in population—the change in age distribution—comes in. The proportion in the population within the productive age has changed between 1870 and 1930 from 55.7 per cent to 63.4 per cent.⁸ Proportionately, therefore, the same body of consumers has a larger body of producers to supply their needs. Relatively this is the same thing as if the consuming power had actually been reduced. Had the productivity per worker decreased proportionately, this result would not have followed; but as we know, the unit productivity has, on the contrary, greatly increased in both industry and agriculture, and therefore the reduction of consuming power relative to producing power is further accentuated.

But, again, this larger group in the productive age might not have been drawn into actual production, and so all might still be well. They might still be only consumers, even though in the productive age group. Actually, however, the number of gainfully employed *has* increased both absolutely and relatively: absolute numbers from twelve million in 1870 increased to forty-eight million in 1930; proportion in population increased from 32 per cent in 1870 to 40 per cent in 1930.⁹ Thirty-two per cent means, on an average, 3.1 consumers for one gainfully employed, including the earner; 40 per cent means 2.5 consumers for one gainfully employed, including the worker, a reduction in ratio of consumers to producers of 20 per cent, to say nothing of increased productivity. Theoretically this might mean, and to some extent it does mean, an easing of the burden: for 2.5 people can more easily be supported

⁸ Hurlin, R. G. and Givens, M. B.: *Shaping Occupational Trends*, a chapter in *RECENT SOCIAL TRENDS IN THE UNITED STATES*. New York and London, McGraw-Hill Book Company, 1933, p. 276.

⁹ *Ibid.*, p. 271.

on the income of one person than can 3.1. That assumes, however, that the earner works and receives wages with the same regularity in 1930 as in 1870. By way of answer, we have had a growing unemployment trend for over two decades. With constriction of market and greater productivity of worker, employment shrinks, and the fewer dependents of an unemployed person have a harder time than the more numerous dependents of an earner. What expansion of activity can be expected when the relative number of consumers is decreasing? A great deal might still have come if the standard of living had risen sufficiently to add to the consuming power and if the purchasing power had similarly kept pace with this increasing capacity to consume. But purchasing power is derived from employment and farm income, and we see that the rate of employment has been consistently diminishing while farm population income compared with farm population has for similar reasons also been decreasing.

There is an abundance of data on these happenings in agriculture, most of them easily available in several publications of the National Resources Board.

If social welfare is dependent primarily on economic welfare, and if welfare measures are to be adjusted to these implications of population change, what measures might be rationally consistent with this movement? Recalling that the proportion in the older age group is increasing and in the younger age group decreasing, one might propose:

1. That the producing power be gradually concentrated in the group, say 20 to 55, leaving those under 20 and over 55 relatively as consumers.

This would imply:

- a. A modified apprenticeship training prior to the age of 20.
 - b. Gradual demobilization of employment beginning about 55, and accelerating to 65, through changing of hours, shifting of occupations, and recognizing superannuation in some cases to be equivalent to eligibility for old-age insurance.
2. Reduction of hours and increase of wages in the producing ages

(20 to 55), so as to spread employment, and distribute and maintain purchasing power.

3. Reorganization and replanning of occupational distribution, by shifting certain blind-alley types of occupation to the age group 50 to 65 as adapted to reduced earning capacity; creating part-time employment in the ages 50 to 65 with appropriate retirement adjustments; excluding the age group, 20 to 50, except among the handicapped, from these selected occupations.

4. Equalization of income among the rural and urban workers through wage and price adjustments and through removing as low-wage competitors, the aged and young workers.

And here is where the specific welfare programs come in, through the development of an educational system suited to the cultural and leisure time requirements of such a civilization, and of health and welfare services adapted to the changing population groups.

Of course, in any such plan which is unavoidably interwoven with population changes, we should have to answer certain questions, also implicit. For example:

Do we wish to counteract the recognized population changes by far-reaching measures that would keep the population increasing indefinitely, or until such time as we have discovered ways of restoring the producer-consumer ratio that had made increasing prosperity possible? These changes would have to be substantial to make a difference. They would involve supplementation of family wage, premiums on large families, bonus for additional children, etc. We would also have to decide whether this increase, which presumably is for purposes of maintaining the tempo of economic advance, is to be applied to all consumers, Negro as well as white, Indian, Mexican, foreign-born, as well as native.

Do we wish really to give economic equality to Negro and white, to agricultural and industrial worker, to manual and white-collar workers?

I should like at this point to pass over the second economic complaint relative to the restriction in possibilities of investment, and first consider the complaint about the expensiveness of welfare services. Here we deal with welfare as representing activities occa-

sioned by lack of income or other handicaps, or by the increasing standards of educational and cultural life. Continuing again on the assumption that the population trend, both as to age distribution and as to the numbers, is likely to continue as outlined, and adding a further assumption that readjustment of wages and hours may not be sufficient to adjust productivity to employment, welfare services would have to be regarded as:

A way by which reasonable living on relatively low income can be made possible and more equitable, since services would be distributed in accordance with need rather than in accordance with earning power and would therefore interfere but slightly with the conflict in wage adjustment between employer and employee. In this conflict the consuming power of one worker compared with another does not enter, and each worker is an equal competitor and collective bargainer with his fellows. Through welfare services rather than through wages, then, the large family of a low-wage earner would be assured of as decent standards as would be the larger earner in a smaller family. The welfare services involved in this concept would include public housing, public medical care, extensive recreation programs, a far-reaching educational system.

They would mean making possible the exclusion or partial exclusion from competitive employment of the young age group, the old age group, and that indeterminate age interval in which productivity decreases and either shift of occupation or part-time employment might be reasonable.

Welfare service might be regarded also as an expanding area of employment, a market for absorbing particularly suitable personnel and an opportunity for expenditures on equipment, maintenance, etc.

These services would represent one of the ways of raising the standard of living which would constitute part of the qualitative increase in consumption power, and multiply the commodity called "services" apace with stable commodities and other "visible" products. Much of the welfare program for children, youth, the aged, mothers, and the chronic ill would come in this category.

They would constitute a stabilizing influence on the financial structure by the consumption of products through public expenditures, which are less subject to violent fluctuations than is competitive busi-

ness. In other words, it is true that welfare services, especially when conceived in a comprehensive way *are* expensive. As "commodities" they reflect a higher level of living for individuals and social groups. Their purchase, through tax payment would draw upon the capital-labor economy as a sort of fixed charge. But these services seem to be also a *way out* of the impasse created by the ever-widening ratio between producing power and consuming power of other economic commodities. The absolute amounts expended on these services at the present out of the national income are almost negligible (as shown by Mr. Nathan's charts—reproduced in *Social Security Bulletin*). They must expand in the interest of economic solvency as well as in the interest of the clients to be served.

The postulate that public welfare services will have to expand far beyond their present scope, and that this expansion is as much an inevitable corollary of population change as it is an expression of welfare interest, renders the subject of investment difficulties pertinent to this discussion. For it is perfectly true that the kind of expanded social welfare program that we are talking about cannot be financed on the current philosophy of the place of capital in the system of distribution. Curiously enough, we do not hear much about lack of income for purposes of consumption in the higher income brackets or in general by those whose livelihood comes in returns from capital. The cry is rather that that part of the income obtained from profits which is not consumed, but is available for investment, cannot be reinvested for further profits. It is assumed that profits have a dual function of making possible high consumption standards and of making possible further profitable investment. The latter notion seems to be held quite independently of the former. I recognize that this is not the place for debating questions of a purely economic nature. The reason for including this point, however, lies in the fact that of all economic factors so often debated as bearing on this point, the effect of population is the only one that is consistently disregarded. The fact that investment for profit implies a consumer as well as producer is considered as some-

thing abstract and irrelevant as within the realm of pure economics and of practical politics, but not of practical economics.

In a recent syndicated article over Mr. Babson's signature, he makes reference to the sixteen billion dollars tied up in private capital which is kept from giving work to eight million unemployed, by implication through pure perversity. Disregarding for the moment the obvious fact that the breakdown occurred prior to the present Federal administration, this sort of analysis leaves entirely out of consideration the order in which products can be consumed: the fact that foods are already produced in overabundance, but cannot be distributed, that dwellings to meet mass demand are not recognized as suitable investment for private capital, and that there is no shortage in luxury products to meet the consumption needs of the upper brackets.

To come back to the main problem, it would seem clear that the social welfare program discussed here can be made possible only by fundamental reorganization of the distribution system. We may regard the present distribution in a simplified form as consisting of three parts, each seeking to expand so as to occupy a larger proportion of the total distribution. One of these is the return to capital, another the return to labor, the third, payment to government for protection and public services. The principal struggle between capital and labor can be interpreted as a pressure of these two divisions into each other's territory. The past few decades have presented a widening of the third division or belt—that part of economic distribution which goes to the government in taxes for public services and of course for public welfare services. The program of increased social services is predicated on the theory that this third belt will continue to be an increasing factor in the system of distribution, absorbing portions of the return to both labor and capital. At this point, the lessons from population change do not automatically give the answer as to whether the cost of services should draw principally from labor or chiefly from capital. That becomes a

question of philosophy and theory of government. Fascist and Socialist interpretations will give different answers. If it is true that purchasing power ought to be maintained or increased, then it would follow that public services must draw more extensively on the portion that now is the return to capital. If, moreover, that part of the return to capital which is not consumed but is waiting for reinvestment remains stagnant, then presumably the cost of social services must come in large part from this uninvestable capital either directly, or through some system of taxation.⁴ The point I am trying to emphasize at any rate is that the difficulties of capital investment are also bound up with changes in population, with the associated facts of our socio-economic structure, and with the place of welfare services in our economy.

This persistent dwelling upon theoretical considerations rather than tackling the simple question of how to adapt programs of social welfare to changing population has been, as you realize, deliberate. These fundamental problems are, I think, from a practical point of view, of far greater importance than specific suggestions. They do, of course, imply certain specific proposals but I regard these as deriving their validity, their practicality, and their permanence entirely from whatever truth there may be in the theoretical considerations that lie behind them. A social welfare program adapted to these considerations would include then, by way of a brief resume, some such items as the following:

1. A continuous program of Federal public employment.
2. Completion of a system of social insurances including those of old age, the extension of unemployment insurance, etc., to all occupations, and the development of insurance against loss of income from sickness.
3. A reorganization of the educational and vocational program which by a combination of schooling and apprenticeship, would keep all persons under 20 out of the field of employment competition.

⁴ It actually does, to a large extent, come from this source at the present through purchase of government bonds. The change in the proportion of sources of bank profits as between commercial loans and government bonds since 1929 is more than suggestive of this.

4. An organized plan for the demobilization of and special employment opportunities for the age group from 55 to 65, or even 70.

5. A reorganization of the entire system of taxation which would make possible:

a. Taxing where taxing capacity exists,

b. Expenditure where services are needed,

c. A concentration of taxation under the Federal Government in such a way that the issues raised as between services and economic system can become clear-cut and intelligible for discussion.

6. Administrative reorganization of relations between Federal, State, and local governments so as to make possible the correlation between employment, social insurance benefits, and welfare services, regardless of State and local boundaries and in full recognition of the fact that intra-national migration requires far-reaching administrative adjustments.

MEDICAL EVALUATION OF NUTRITIONAL STATUS¹

II. MEASUREMENT OF VISUAL DARK ADAPTATION WITH THE ADAPTOMETER

ELEANOR P. HUNT AND CARROLL E. PALMER

INTRODUCTION

THE measurement of visual dark adaptation described in this report was part of a cooperative nutrition study, which was directed toward an appraisal of methods of investigating the nutritional status of apparently well persons. The purpose and scope of the study and procedures employed have recently been described (1).

In nutritional examinations, dark adaptation measurements are a basis of inference regarding the presence of nyctalopia, a condition of impaired retinal sensitivity under dim illumination, arising from avitaminosis A. The sensory phenomenon of dark adaptation, as expressed in threshold measurements, reflects the synthesis of photosensitive pigment and the corresponding recovery of sensitivity of the retina after exposure to light. The regression of threshold upon time in the dark describes the course of the individual's retinal recovery.

The present report on dark adaptation represents an attempt to obtain information on the accuracy of threshold measurements obtained with a particular adaptometer. The demarcation between adequacy and deficiency in vitamin A nutrition, we believe, cannot be defined satisfactorily until the accuracy of threshold measurements has been evaluated and the major factors other than vitamin A, contributing to the variability of threshold measurements are

¹ This paper is the second of a series from a cooperative investigation by the Milbank Memorial Fund; the New York City Department of Health; the United States Public Health Service, Division of Public Health Methods; and the Cornell University Medical College, Department of Public Health and Preventive Medicine and Department of Pediatrics.

The cooperating agencies have been assisted in carrying out this investigation by the Work Projects Administration for the City of New York, Official Project No. 65-1-97-21, W.P. 24, "Medical Evaluation of Nutritional Status."

identified. Such preliminary evaluation of the technique of measurement provides essential information whereby experimental error can be minimized and discriminating observations can be made with respect to such nutrition categories as may later be defined.

MATERIAL AND METHODS

The Adaptometer. Measurements of dark adaptation dealt with in this report were made with the adaptometer designed and described in detail by Hecht and Shlaer (2). This adaptometer is a device for exposing one eye of a subject to a light of standardized brightness (preadaptation) and for measuring the dark adaptation of that eye by determining, at specified intervals of time, the threshold of perception of light stimuli of measured intensity. An instrument, constructed according to the specification of Hecht and Shlaer, can be purchased in the commercial market.² So obtained, the adaptometer is considered complete for routine measurement of dark adaptation. Three of these adaptometers, carrying the manufacturer's serial numbers 5, 9, and 16, were obtained and used in the present study.

Procedure of the Test. Except for certain details which will be considered later, the test procedure used in the present study was that described by Hecht and Shlaer (2). The right eye of the subject was always tested unless it was missing or presented an obvious abnormality. The location of the retinal field involved both in preadaptation and in dark adaptation was determined by adjusting the light and dark fixation points so that the points were viewed 7° nasally. Preadaptation time was held constant at 3 minutes and covered a retinal area of approximately 35° in diameter. The flashes of light used during dark adaptation were adjusted at 0.2 second and covered an area 3° in diameter. The violet filter (Corning 511) was always used for the threshold determinations so that only wave lengths below 460 millimicrons were transmitted. Threshold

² From Mr. O. C. Rudolph, 55 Van Dam Street, New York, N. Y.

measurements were made during the first minute following pre-adaptation and thereafter at intervals of from 2 to 4 minutes for a period of from 30 to 40 minutes. The brightness of the adaptation light and of the test flash during dark adaptation was expressed in the logarithm of micromicrolamberts ($\mu\mu l$).

The classification of the several observations during a given adaptation into rod or cone, was accomplished by a consideration of the speed and velocity of adaptation during the first 15 minutes as well as the reported color of the image. We have found color reports under field conditions too inconsistent with expected results to serve as a certain basis for distinguishing cone and rod thresholds. The terms, cone and rod, are used in this discussion to refer respectively to thresholds before and thresholds after the first apparent plateau during adaptation, without implication as to its reality or its physiological significance.

The three adaptometers used in the study were operated in a dark room in which separate booths were arranged for each instrument. A partition in each booth, through which the eye piece of the adaptometer projected, furnished two cubicles, one for the subject and the other for the technician and adaptometer. By this arrangement the subject was completely shielded from stray light during the test. An adjustable chair, and an arm rest placed below the eye piece of the adaptometer, were provided for the subject.

The procedure of determining a threshold during dark adaptation was to obtain a series of verbal responses from the subject to a number of flashes of light given in fairly rapid succession. The threshold was the brightness, between narrow limits, which corresponded, respectively, to images seen ("Yes," response), and images not seen ("No," response). The technician reduced the limits as much as possible by varying the intensity of illumination in relation to the subject's verbal responses. In general, the brightness of the test flash was decreased when the subject's response was "Yes," and increased when the response was "No." The brightness record-

ed as the threshold was the critical level dividing "Yes" and "No" responses. The time, at which the critical level was obtained, was recorded as the observation-time of the threshold.

Before the beginning of the test, the technician explained its characteristics to the subject, mentioning the preadaptation period, and the subsequent dark adaptation in order to familiarize the subject with the test and his rôle in it. The technician also exhibited several flashes at different intensities and the subject was given some preliminary experience in responding, after each operation of the shutter, as to whether the test light had been seen or not. The subject was instructed also to view the dark point during light adaptation and the light point during dark adaptation, and inform the technician, in the latter case, when the point was more than just perceptible in order that the technician might maintain the light fixation point at the just perceptible level.

Technicians. The instruments were operated by three laboratory technicians under the supervision of a senior technician of the field service of the United States Public Health Service. Each of the technicians was instructed in the procedure of the test by the same supervisor and had field experience before making regular examinations.

INSTRUMENTAL VARIATIONS

Experimental work with the three commercially procured adaptometers clearly indicated that comparable dark adaptation data would not be obtained from the three different instruments if they were used as purchased. For example, it was found that repeated tests made on the same subject with the same adaptometer were very similar. Other tests, on the same subject, made on a different adaptometer, were grossly and significantly different from those made on the first adaptometer. Since it was essential that data from the several adaptometers be directly comparable, a study was made of the sources of these instrumental variations. As a result of this study, and the changes subsequently made in the instruments, it

was found possible to obtain comparable results with the three different adaptometers. The elimination of differences between the adaptometers is of interest as a special case of the more general problem of maintaining comparability of data from different laboratories using this type of adaptometer. Uniformity of apparatus and procedure will promote the collection of comparable data and minimize the purely technical sources of difference which are often confounded with nutritional, biological, or regional factors.

Differences in Optical Parts. The first source of instrumental variation involved differences in the composition of the "neutral" wedge and filters which are parts of the intensity control assembly. The adaptometers having serial numbers 5 and 9 were found to be equipped with Wratten gelatin-between-glass wedges while the wedge in instrument number 16 was made of Jena glass. The set of "neutral" filters for adaptometer 5 were Wratten gelatin-between-glass while those for instruments 9 and 16 were Jena glass. After some use, the gelatin-between-glass wedge and balancer of adaptometer 5 were found to have become noticeably faded and the cementing material was affected. It is well known that the physical properties of gelatin-between-glass units are impermanent and their calibrations accordingly unstable. Since the calibrations of glass wedges and filters can be depended upon, all gelatin-between-glass parts were replaced by glass parts.

Calibration of Violet Filters. The second source of instrumental variation involved the density factors of the violet (Corning 511) filters which are used during the dark adaptation part of the test. According to the data supplied by the manufacturer these factors for the filters in instruments 5, 9, and 16 were, respectively, 3.011, 2.721, and 2.723. A check of the calibrations at the United States Bureau of Standards* resulted in the following values: 2.932, 2.932,

* The method of calibration used at the United States Bureau of Standards depends on a determination of spectral distribution of transmission on a recording photoelectric spectrophotometer. The transmission factors for incandescent lamp light at 2700°K were computed from these data and using I.C.I. luminosity factors. (3)

and 2.943 for the filters from instruments 5, 9, and 16, respectively. Differences between the maker's density factors and those obtained at the Bureau of Standards apparently derive from different methods of calibration. The practical results of adopting the new calibrations were: threshold values obtained on instruments 9 and 16 were dropped to the lower level characteristic of instrument 5 and the calibration of the chromatic filters was placed on a standard and more reliable basis.

Calibration of the Light Source. A third type of variation arose in connection with the problem of estimating the brightness of the light source in the adaptometer. This source, which is used both in preadaptation and in the dark adaptation phase of the test, is a fixed ground-glass window of the lamp housing which is illuminated by an ordinary commercial 40-watt, inside-frosted tungsten filament lamp operated on a definite current, 115 volts. A precise measurement of the brightness of the light source is a necessary part of the operation of the adaptometer since the brightness value figures directly in the calculation of each threshold determination. The measurement of brightness is necessary also whenever a lamp burns out, or is replaced, and is desirable from time to time as a check on changes in the lamp. Obviously, it is necessary that the user of the adaptometer be able to measure this brightness accurately. For this purpose, each commercial adaptometer is provided with a "standard reference lamp." The procedure of measurement involves a matching of the brightness of the light source of the standard lamp with that of the adaptometer. In actual practice this entails a heterochromatic match. In instrument 9, for example, the half of the field illuminated by the light source of the adaptometer was greenish in hue, whereas the other half of the field illuminated by the standard lamp appeared to be orange. The difficulty of matching brightness when the sources compared are different in color is well known (3).

Study of the use of the standard reference lamp in calibrations of

the adaptometer light source showed that estimates of brightness obtained by different observers were highly variable. It was found, for example, that three different observers estimated the bright-

Table 1. Variance of measurements of brightness of the source when calibrated with the standard lamp of the adaptometer.

Source of Variation	Degrees of Freedom (Number)	Mean Square ($\log \mu \mu I$) ²
TOTAL	239	1.429
Between Different Observers	14	21.655*
Between Repeated Readings by Same Observer	222	.006
Combined Error of Observation	236	1.291

* $p < .01$.

ness ($\log \mu \mu I$) of the source light of instrument number 16, as 12.606, 12.689, and 12.817, respectively. For instrument number 5, the same observers reported 12.364, 12.072, and 12.316 as the brightness. These results are mentioned to illustrate the range of results when the brightness of the adaptometer light source was repeatedly matched to that of the standard lamp as reference by different observers.

To obtain a measure of error of this method of calibration of the source, an analysis of variance was made of 240 observations contributed by five different observers for light sources whose brightness was in the neighborhood of 12.00 log units. Each observation involved a match of the brightness of the source of the adaptometer with that provided by the standard lamp, by variation of the wedge setting of the adaptometer. Table 1 shows the variance of the observations for the same observer and for different observers. From this analysis it appeared that the variance of observations repeated by different observers, is 1.291. This estimate included the variance between different observers as well as the variability of repeated readings by the same observer. Since the variance of such observations was large, it follows that the actual brightness was subject to considerable uncertainty. Thus, for theoretical sample means of

fifteen repeated observations by different observers the chances were 19 to 1 that the actual mean brightness was within the interval $\pm .572$ log units. The value $\pm .572$ serves to indicate the extent to which the inferred brightness could vary and still be consistent with the sample observations.

The inability of different observers to arrive at results which correspond more closely made it necessary to find a more reliable method for the calibration of the light source of the adaptometer. Use of the Macbeth illuminometer, in place of the standard reference lamp supplied with the adaptometers, appeared to be satisfactory. An analysis of variance similar to that described above was made for observations obtained with this illuminometer. For theoretical sample means of fifteen repeated observations by three observers, the chances were 19 to 1 that the actual mean brightness was within the interval $\pm .01$ log units. Observations with the Macbeth illuminometer provided, therefore, the highly discriminating information which is necessary regarding the brightness of the source of light in the adaptometer despite plurality of observers.

Other ways of obtaining reliable estimates of the light source in the adaptometer are of course possible. Thus the standard reference lamp might be modified to eliminate the heterochromatic comparison. Suitable filters would reduce the discrepancy in color between reference field and the light source of the adaptometer. The color difference between the reference and the adaptometer source would be reduced if the standard lamp were operated more nearly at rated current. If the latter expedient were adopted, the reference lamp of the standard would need to be housed so that its position could be varied. A combination of these or similar modifications would increase the reliability of results with the standard lamp.

Differences of Brightness in Preadaptation. Specifications for the adaptometer indicate that the 40-watt lamp operated at 120 volts will provide a source for preadaptation whose brightness is in the

neighborhood of 12.176 log units of $\mu\mu l$ (1,500 millilamberts). It is generally agreed that such small differences as might be found in the brightness of commercial 40-watt lamps would not materially affect the thresholds of light perception determined during dark adaptation. However, the effective brightness of the light source from such lamps may vary under operating conditions.

Estimates of the brightness of the preadaptation lights in adaptometers numbers 5 and 16 were made with the Macbeth illuminometer and found to be, respectively, 11.793 log units (approximately 620 millilamberts) and 12.024 log units (approximately 1,060 millilamberts). While this difference is not large, it is greater than could be explained by the random variation alone, of 40-watt, commercial tungsten filament lamps. Two questions are raised by this finding: First, what instrumental factors bring about the variation in different adaptometers? Secondly, do differences of this magnitude give rise to physiologically significant differences in dark adaptation?

A partial answer to the second question was obtained from an analysis of tests of 175 children made with instrument number 16 and of 179 children made with instrument number 5. Data from this analysis are shown in Table 2 and Figure 1. The means of threshold at successive minutes in the dark, following the slightly greater preadaptation of 12.024 log units on instrument 16, were consistently higher than the corresponding means after preadaptation on instrument 5 with 11.793 log units, except after 20 minutes in the dark.

If the difference in preadaptation brightness was much greater than in the above tests (0.231 log units), the differences in threshold values before 20 minutes in the dark were larger, and significant differences were found as well after 20 minutes in the dark. A number of individuals were tested with varying preadaptation brightness. Figure 2 illustrates, for two individuals, the course of dark adaptation following differences in preadaptation bright-

MINUTES IN THE DARK	INSTRUMENT 16		INSTRUMENT 5	
	Preadaptation Brightness ($\mu \mu I$) 12.024 Log Units		Preadaptation Brightness ($\mu \mu I$) 11.793 Log Units	
	Cases Observed at Time Specified	Mean Threshold (Log of $\mu \mu I$)	Cases Observed at Time Specified	Mean Threshold (Log of $\mu \mu I$)
<i>Cones</i>				
.5	172	6.436	179	6.217
1.5	3	6.145	0	—
2.5	157	5.847	163	5.651
3.5	15	5.722	14	5.693
4.5	94	5.561	94	5.360
5.5	52	5.420	60	5.309
6.5	26	5.337	27	5.145
7.5	24	5.254	33	5.107
8.5	9	5.168	4	5.075
<i>Rods</i>				
7.0	58	4.693	54	4.406
8.0	46	4.230	52	4.046
9.0	50	4.051	46	3.779
10.0	81	4.006	88	3.852
11.0	56	3.678	74	3.475
12.0	52	3.719	46	3.396
13.0	84	3.470	82	3.366
14.0	63	3.352	65	3.186
15.0	46	3.218	55	3.114
16.0	78	3.181	75	3.024
17.0	56	3.100	56	2.994
18.0	49	2.902	48	2.811
19.0	61	2.936	59	2.907
20.0	54	2.831	60	2.833
21.0	48	2.779	53	2.698
22.0	51	2.714	49	2.740
23.0	56	2.656	54	2.631
24.0	56	2.607	66	2.629
25.0	51	2.597	49	2.598
26.0	58	2.552	54	2.569
27.0	55	2.508	54	2.511
28.0	50	2.511	61	2.510
29.0	59	2.457	50	2.493
30.0	56	2.463	65	2.447
31.0	48	2.436	43	2.496
32.0	51	2.409	60	2.438
33.0	50	2.445	59	2.436
34.0	58	2.423	51	2.469
35.0	50	2.398	62	2.437
36.0	53	2.414	56	2.424
37.0	47	2.422	35	2.434

Table 2. Mean threshold during dark adaptation after preadaptations differing in brightness by 0.23 log units.

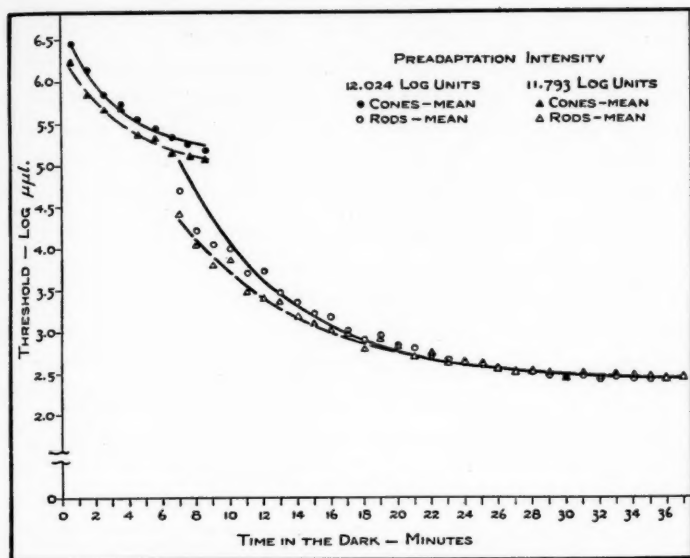


Fig. 1. Regressions of mean threshold during dark adaptation after preadaptation with lights differing in brightness (intensity) by 0.23 log units.

ness of approximately 0.5 log units. In the case of one subject (T. Z.), the differences in threshold, presumably due to preadaptation difference, were evident and large, until 28 minutes in the dark. The response of the other subject was similar. The discrepancy in the threshold curves illustrated by these subjects was representative of the results obtained for other subjects in a series of such tests. The analysis of this question in general indicated that if thresholds earlier than 30 minutes are to be used and compared, uniform preadaptation is indispensable.

Adjustment and Control of Brightness in Preadaptation. Since it appeared necessary, an attempt was made to adjust the preadaptation brightness of the three adaptometers to a uniform value. To date, this attempt is not considered entirely satisfactory.

A priori considerations indicated that the differences among the

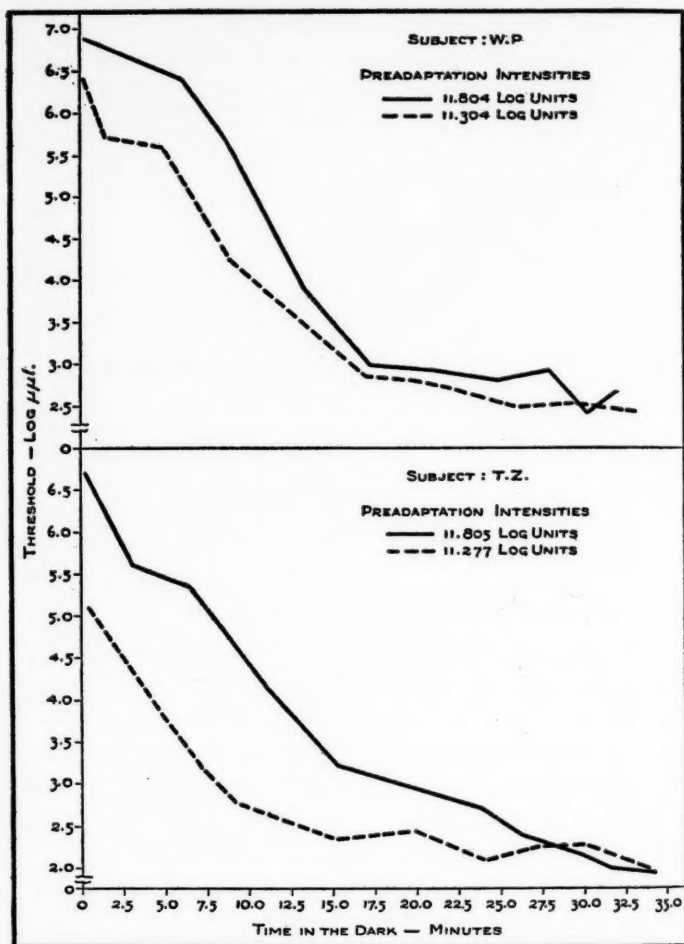


Fig. 2. Dark adaptation curves for two subjects (W.P., T.Z.) after preadaptations with lights differing in brightness (intensity) by approximately 0.5 log units.

three adaptometers were due to some combination of the following factors: (a) differences of one-quarter transmitting "neutral" filters

used during preadaptation, (b) position of the lamps as placed in their sockets, (c) distances of the lamps from the ground-glass windows of the housings, (d) differences in the thickness or composition or installation of the ground-glass windows. Although no study of the relative importance of these factors has been made, it was likely that they accounted for a major part of the observed difference in the brightness of the preadaptation lights. While it probably would be most desirable to equalize the preadaptation brightness of the several instruments by varying the distance between the lamp and the ground-glass window of the housing, the structural changes required did not appear feasible without considerable alteration of the present design of the adaptometer.

The method finally adopted to equalize preadaptation brightness for the present study was an adjustment of the operating current by means of a manually-controlled rheostat and voltage regulator assembly attached to each adaptometer. It was found that the maximum uniform brightness to which the three adaptometers could be adjusted, by variation of operating current, was 12.002 log units (1,004.4 millilamberts). The reference standard of brightness, while adjusting the operating current of the individual adaptometers, was the Macbeth illuminometer, set to provide 1,004.4 millilamberts. The one-fourth transmitting "neutral" filter was in its position for preadaptation, while the brightness of the adaptometer light source was matched to that of the reference standard, by the requisite adjustment of operating current. Thus, the adjusted current compensated differences between the one-fourth transmitting "neutral" filters as well as those from sources previously mentioned. When illuminated by a 40-watt lamp, the window of the lamp housing of adaptometer 5 did not yield the desired 12.002 log units of preadaptation brightness. A 50-watt lamp has been installed in this adaptometer. Table 3 summarizes the details of the operating conditions.

In the case of instrument 16, the adaptometer lamp was operated

INSTRUMENT NUMBER	WORKING LAMP (WATTS)	OPERATING CURRENT (VOLTS)	BRIGHTNESS OF SOURCE (LOG OF $\mu\mu I$)	DENSITY OF TRANSMITTING "NEUTRAL" FILTER (LOG OF $\mu\mu I$)	PREADAPTATION BRIGHTNESS (LOG OF $\mu\mu I$)
5	50	111.4	12.522	.520	12.002
9	40	109.1	12.512	.510	12.002
16	40	106.7	12.529	.527	12.002

Table 3. Operating conditions of different adaptometers, modified to obtain uniform brightness of preadaptation.

at approximately 13 volts below rated current. The respective operating currents of the other instruments fell short, also, by smaller amounts of the rated voltage. A change of 10 volts causes a change of about 100 degrees in color temperature for the 40-watt, 120 volt, inside-frosted lamp and a corresponding slight decrease in the transmitting factor of the violet filter. The color temperature of the 40-watt lamp, such as that installed in adaptometer 9, for example, is in the vicinity of 2,700°K when rated current of 120 volts is applied to the terminals. The density assigned to the violet filter at this color temperature was 2.932. At 2,600°K the density of the same filter would be 2.971. The small change in density was a negligible source of variation in threshold compared with the differences attributable to discrepancy in preadaptation brightness when the adaptometers were operated without compensating adjustments of current. The adjustment of current alone was adopted temporarily as the most feasible expedient to bring about uniform preadaptation brightness.

A preadaptation brightness of 12.00 log units (approximately 1,000 millilamberts) was selected primarily because of structural characteristics of the adaptometers and certain operating conditions which obtained in the present study. In order to make possible the direct comparison of dark adaptation data from different laboratories, there obviously must be general agreement among workers in the field to use this or some other standardized brightness value.

ERRORS OF MEASUREMENT

The accuracy of the dark adaptation test, like other physiological tests, is dependent upon a complex of factors which may be grouped together under the general heading of "errors of measurement." For example, the accuracy of a particular threshold during dark adaptation is dependent upon the accuracy of the technician's reading of the wedge setting, upon the subject's attention at the moment of the flash of light, upon the precision with which the subject followed instructions during the preadaptation phase of the test, and upon many other variable factors. An attempt has been made to measure several of the more obvious sources of errors of measurement in the adaptometer test.

Variation in the Perception of the Test Light During Dark Adaptation. Determination of the threshold during dark adaptation must depend to some extent on the subject's interpretation of how bright the test light must be before he reports that he is just able to see it. That is, subjects probably differ considerably with respect to their definition of perceptible and nonperceptible flashes of light. Further, the same subject may change during the course of a test his definition of what is perceptible. A limited set of observations was made with a carefully trained subject to determine the magnitude of this source of variation.

After a period of 30 minutes in the dark, the subject was asked to respond to each of four successive series of flashes according to the following four respective grades of perceptible test flashes:

1. Images which were just perceptible as a presence, or perhaps a glow, but without form and without luminous effect.
2. Images which were definitely perceptible, more than a glow, but still without form and only a slight luminous effect.
3. Images which were characterized by a slight form effect, not well defined, and only faintly luminous.
4. Images which were bright and with form sufficiently well defined to be described as approaching a circle.

For each class of image the subject was shown the usual short series of flashes. The threshold was determined for each of the image groups in the order given. The results show that there was a gradual elevation of the threshold as the definiteness of the image increased with respect to form and luminous effect. The means of these thresholds, in each image group, are summarized in Table 4.

Table 4. Mean threshold according to subject's definition of perceptible image.

Definition of the "Image Perceived," Controlling "Yes" Response of the Subject	Number of Observations	Mean Threshold (Log of μl)
1. Just Perceptible, Form and Color Absent	9	2.647
2. Definitely Perceptible	9	2.879
3. Form Present	13	3.134
4. Bright Image with Form	12	3.298

The means differ significantly although the number of observations in each group was small. After 30 minutes in the dark a trained subject reported the threshold of just perceptible images to be 2.647 log units. The average of definitely perceptible images was 2.879 log units, or 0.232 log units above the average of just perceptible images. The average for images that were definitely bright with form (Class 4) was 3.298, or 0.651 log units above the average of just perceptible flashes.

At the present time no information is available on the extent to which untrained individuals may change their subjective definition of a just perceptible flash during the course of a single dark adaptation test; nor is there information on the differences among different individuals as to their personal criteria of how bright a flash of light must be before they report it as being just perceptible. It seems possible, however, that in routine dark adaptation tests a difference among different individuals of as much as .5 log unit in the threshold after 30 minutes may be due to differences in subjective criteria of perception.

The above analysis and interpretation is of special interest in con-

nection with the distribution of threshold responses for different individuals. Lindquist (5), Hecht and Mandelbaum (6), and others have presented data which indicate that the variability of threshold values of presumably normal persons after 30 minutes in the dark covers a range in the neighborhood of 1.0 log unit. A substantial proportion of this range, therefore, may be due to variation in the subjects' criteria of perceptible flashes.

Variation of Threshold Determinations for a Given Individual. To obtain information on variations characteristic of the subject, and his response to the test, duplicate tests have been made for eighty-three subjects. Each subject was tested twice, the second test following the first test after a lapse of 20 minutes, during which the subject was permitted to leave the dark room and move about at ease in the laboratory. In some instances, subjects sat quietly in the laboratory between repeated tests. The instrument, observer, and test procedure were identical for first and second tests of the duplicate set. The only difference between the first and second tests was one of order. To obtain an estimate of difference in threshold values at several observation times, the observations were made at certain specified times during the test. They were at .5, 3.5, 6.5, 9.5, 12.5, 15.5, 18.5, 21.5, 24.5, 27.5, 30.5, and 33.5 minutes in the dark. The actual observation time of the threshold might vary by ± 30 seconds from the time specified. This range of tolerance was more than sufficient, and in practice the actual observation time corresponded to the specified time within a few seconds.

One or two of the eighty-three subjects had had previous experience with the adaptation test. For the other subjects, the duplicate tests were the only adaptations experienced. There were sixty-one men and twenty-two women in the group. Their ages ranged from 20 to 65 years. It is likely that the response of this group to the test may be regarded as typical of the performance of lay subjects who are average in interest and intelligence.

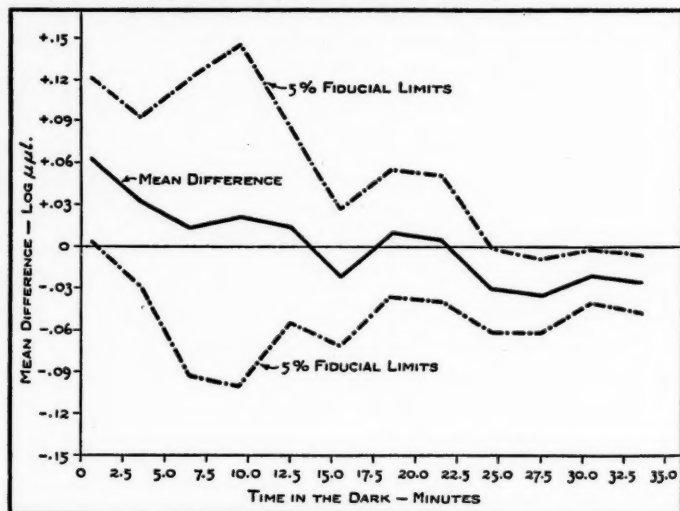
In Table 5 are shown the mean difference, its standard error

MINUTES IN THE DARK	CASES OBSERVED AT TIME SPECIFIED	DIFFERENCE IN THRESHOLDS (LOG OF $\mu\mu l$)						
		Mean	Standard Deviations	s	Standard Error	Range	Fiducial Limits 5 Per Cent	
.5	83	+.063	.2657	.1879	.0292	-1.44 + .73	+.005 +.121	
3.5	83	+.032	.2772	.1960	.0304	-1.23 +1.00	-.028 +.092	
6.5	83	+.014	.4899	.3464	.0538	-1.95 +1.48	-.093 +.121	
9.5	83	+.022	.5636	.3985	.0619	-2.01 +1.62	-.101 +.145	
12.5	83	+.014	.3161	.2235	.0347	-.84 + .97	-.055 +.083	
15.5	83	-.022	.2276	.1609	.0250	-.73 + .64	-.072 +.028	
18.5	83	+.010	.2155	.1524	.0236	-.49 + .43	-.037 +.057	
21.5	83	+.006	.2072	.1465	.0227	-.48 + .56	-.039 +.051	
24.5	83	-.031	.1387	.0981	.0152	-.50 + .34	-.001 -.061	
27.5	82	-.035	.1212	.0857	.0134	-.52 + .21	-.008 -.062	
30.5	83	-.021	.0872	.0617	.0096	-.34 + .17	-.002 -.040	
33.5	82	-.026	.0912	.0645	.0101	-.43 + .12	-.006 -.046	

Table 5. Difference in threshold, at corresponding times in the dark, between determinations in two consecutive dark adaptation tests.

and the standard deviation of the distribution of differences, and other data, according to the time in the dark at which the thresholds

Fig. 3. Mean difference in threshold, at corresponding time in the dark, between duplicate dark adaptation tests. (First test minus second test.)

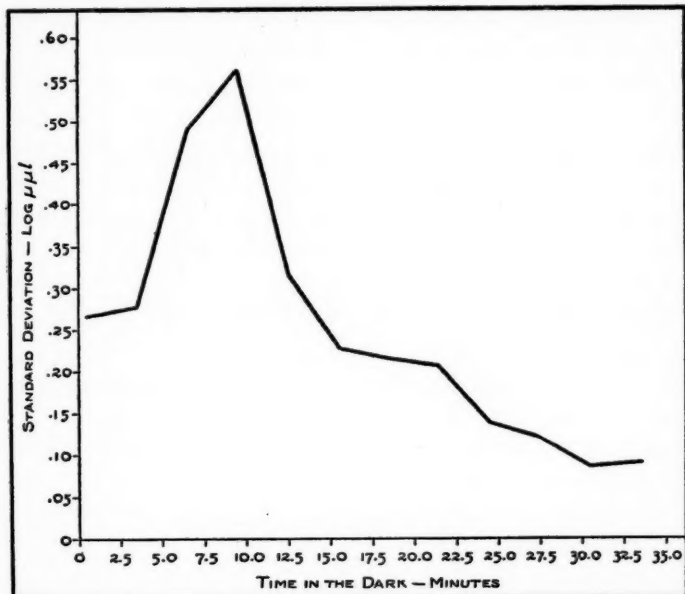


were determined. In computing the difference, at any given time, between the first and second tests, the value of the threshold obtained for the second test has been subtracted from the value obtained during the first test.

In Figure 3 the mean difference and its 5 per cent fiducial limits, at successive observation times, are shown. At 0.5 minute the threshold was significantly higher in the first test of the pair of duplicates. At 24.5 minutes and later, the threshold was significantly higher in the second test.

Figure 4 shows the trend of the standard deviation of the difference between duplicate tests. The variability increased rapidly to a maximum of 0.56 log units at 9.5 minutes, after which there was an equally rapid decline to approximately 15.5 minutes, and a con-

Fig. 4. Standard deviation of the difference in threshold, at corresponding time in the dark, between duplicate dark adaptation tests. (First test minus second test.)



tinued slower decline to a minimum of 0.09 log units at 30.5 and 33.5 minutes. Thus, relatively large differences were common earlier in the test. If the extreme variations are considered as shown in the range, it is found that the discrepancy between duplicate readings for the same individual may equal or exceed a whole log unit at 9.5 minutes or earlier. At 30.5 and 33.5 minutes the total range of observed differences did not exceed .5 log unit and the majority of differences were in the interval $\pm .10$ log units.

From the standard deviation of the difference, at each observation time, the variability of a hypothetical population may be estimated from which the repeated observations may have been drawn. Such variabilities are shown in column 5 of Table 5. If these variabilities are regarded as a measure of experimental error, it is evident that only larger differences in threshold can be distinguished from error before approximately 25 minutes. When judging changes in the individual's threshold, or when attempting to evaluate individual and group differences, more discriminating observations can be made after 30 minutes in the dark.

The observed differences and their variabilities are conditional upon the standard routine of the test in these examinations. A less detailed standardization of procedure would be expected to lead to even greater and more variable differences. Also, if preadaptation brightness, the size and position of the test field, duration and color of test object, and other specifications of the test were altered, the correspondence between duplicate tests would no doubt vary widely from the present findings.

It is worthy of note that the larger differences between duplicate thresholds and therefore the less reliable observations were obtained at the time when cone adaptation was slower and rod adaptation was presumably most active.

The significantly lower value of the threshold at 0.5 minute for the second test may well reflect a learning process during the duplicate tests.

By the end of the first test, the subject had experienced the just perceptible flash of the nearly dark-adapted eye. Such flashes lack form and color and the image is often a presence without other well-defined characteristics. It is not unlikely that persons who have experienced the image of the just perceptible final flashes, do, on retest, revise their concepts of seen and not seen, so that at the time of the second test, affirmative responses are given earlier to marginal images which would at first have been reported as not seen. It should be considered also that the subject may become conditioned to the sound of the shutter and doubtful images may be reported as seen when actually the response is to the sound of the shutter.

SUMMARY

In the present study, field experience with the adaptometer described by Hecht and Shlaer indicates that certain modifications and extensions of the original specifications are desirable if comparable results are to be obtained for different instruments within a given investigation and for different instruments in different laboratories. In brief, the following suggestions are made:

1. To ensure stable calibrations of the wedge and "neutral" filters, these parts of the intensity control system should be made of glass. The impermanence of gelatin-between-glass is well known and no assurance can be given, even if the original calibrations are accurate that they will remain so.
2. A check of the calibration of chromatic filters in commercially procured instruments is desirable. The error of calibration of these filters can be reduced by employing a standard procedure of calibration, less dependent upon the visual idiosyncracies of the individual observer.
3. Use of the "standard reference lamp" supplied with the adaptometer indicates that estimates of the brightness of the light source, obtained with this standard, differ significantly according to the observer. Either another reference standard should be used or the present one modified. In the present study, estimates of brightness with the Macbeth illuminometer appeared to be satisfactory.

4. As now constructed, the preadaptation brightness of the adaptometer cannot be controlled conveniently. Adjustment of the operating current, by means of a manually-controlled rheostat and voltage regulator assembly attached to each adaptometer, was adopted temporarily in the present study as the most feasible expedient to bring about uniform preadaptation brightness. Data are presented which show that uniform preadaptation brightness is essential if comparable results during dark adaptation are to be obtained with different instruments.

Under the heading of "errors of measurement," the results of two experiments are reported:

1. Variation in the subjective criteria of perceptible light flashes may be of sufficient magnitude to account for a considerable proportion of the variation among different individuals in final threshold values obtained after 30 minutes of dark adaptation.

2. Study of duplicate adaptometer tests indicates that there is a marked difference in the reliability of threshold measurements for different periods during dark adaptation. The variability of duplicate tests increases rapidly from 30 seconds to a maximum at 9.5 minutes and thereafter declines to a minimum of ± 0.09 log units after 30 minutes of dark adaptation.

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